
**PERCEPTION OF QUALITY OF LIFE
FOR ADULTS WITH HEARING IMPAIRMENT
IN AOTEAROA/NEW ZEALAND**

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Abstract

Aims: This study investigated the perception of generic and disease-specific Health-Related Quality of Life (HRQoL) for adults living with hearing impairment (HI) in Aotearoa/New Zealand (NZ). This study aimed to answer three questions: (1) What is the perception of HRQoL amongst adults with hearing impairment in NZ? (2) How do these perceptions compare to adults with HI living in other countries for which we have data? (3) What are the demographic and audiometric variables related to device ownership?

Method: HRQoL, demographic, and audiometric information was collected from 126 adults in NZ. The following demographic information was collected: age, relationship length, hours worked per week, income, ancestry, sex, level of education, city size, and sexual orientation. The following audiologic information was also collected: ownership of hearing aids (HA), ownership of hearing assistance technology (HAT), better-ear pure-tone average (BEPTA), worse-ear pure-tone average (WEPTA), and signal-to-noise ratio loss (SNR loss). HRQoL information was collected using the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36; Ware & Sherbourne, 1992), and the Hearing Handicap Inventory (HHI) for both elderly (HHIE) and adults (HHIA; Ventry & Weinstein, 1982; Newman, Weinstein, Jacobson, & Hug, 1991). Variables discriminating HA and HAT owners from non-owners were also analysed.

Results: The relationship between demographic variables and HRQoL scores revealed that only age and income were significant. Audiometric variables had significant relationships with disease-specific HRQoL scores, as well as HA and HAT ownership. Finally, disease-specific HRQoL scores and all audiometric variables differentiated HA owners from non-

owners, but demographic variables did not. Generic HRQoL scores and all audiometric variables differentiated HAT owners from non-owners.

Conclusions: These results suggest that the negative impacts of HI on HRQoL as reported overseas are also present in NZ, and that not only do audiometric variables including SNR loss are related to HRQoL, but HRQoL is a significant predictor for HA and HAT ownership. Further QoL research is warranted amongst the HI population in NZ to identify and understand any causal relationships present amongst these variables. Furthermore, HRQoL instruments and a test of speech understanding in noise have been shown to provide additional meaningful information, and therefore clinicians might consider including them during consultation.

Table of Contents

Acknowledgements	i
Abstract.....	i
Table of Contents	iii
List of Abbreviations	vi
List of Figures.....	vii
List of Tables	viii
Chapter One: Introduction	10
1.1 Overview	10
1.2 Hearing Impairment	12
1.2.1 Overview	12
1.2.2 Prevalence.....	16
1.2.2.1 Objective and subjective measures of prevalence.....	16
1.2.2.2 HI and age	16
1.2.2.3 Degree and definition of hearing impairment	17
1.2.2.4 Location of population	19
1.2.2.5 Division by sex.....	20
1.2.3 Impact of hearing impairment	20
1.2.3.1 Impact of health conditions	20
1.2.3.2 Measuring the impact of hearing impairment – quality of life	24
1.2.3.3 Measuring the impact of hearing impairment – health-related quality of life	24
1.2.4 Effect of intervention on the impact of hearing impairment	30
1.2.4.1 Audiologic factors	33
1.2.4.2 Demographic factors and hearing aid adoption	35
1.2.5 Benefit of intervention.....	38
1.2.5.1 Cochlear implants.....	38
1.2.5.2 Hearing aids	38
1.2.5.3 Hearing assistance technology (HAT)	38
1.3 Hearing Impairment and Quality of Life.....	40
1.3.1 Age.....	41
1.3.2 Relationship status	43
1.3.3 Hours worked per week	43
1.3.4 Income	44
1.3.5 Ancestry.....	44

1.3.6 Sex	45
1.3.7 Level of education	47
1.3.8 City size	47
1.3.9 Sexual orientation	48
1.4 Study Rationale	49
1.5 Aims and hypotheses	50
Chapter Two: Method	53
2.1 A Priori Sample Size Analysis	53
2.2 Participants	53
2.3 Recruitment	54
2.3.1 Newsprint media	55
2.3.2 Television media	55
2.3.3 Radio media	55
2.3.4 Magazines, posters, and other print media	55
2.3.5 Electronic media	56
2.3.6 Word of mouth	56
2.4 Procedures	57
2.5 Measures	58
2.5.1 Quality of life	59
2.5.2 Audiometric variables	59
2.5.2.1 Hearing impairment	59
2.5.2.2 Speech understanding in noise	60
2.6 Statistical Analyses	62
2.7 Ethical Considerations	62
Chapter Three: Results	64
3.1 Overview	64
3.2 Sample Characteristics	64
3.2.1 Demographic variables	65
3.2.2 Audiologic variables	71
3.2.3 Quality of life	71
3.3 Hypothesis 1	72
3.3.1 Hypothesis 1(a)	72
3.3.2 Hypothesis 1(b)	74
3.4 Hypothesis 2	76
3.4.1 Hypothesis 2(a)	76
3.4.2 Hypothesis 2(b)	78
3.5 Hypotheses Summary	79

3.6 Discriminant analysis	79
3.6.1 Outliers	84
3.6.2 Discriminant analysis summary	84
Chapter Four: Discussion.....	86
4.1 Relationship Between Generic HRQoL and Demographic Variables	86
4.1.1 Age.....	87
4.1.2 Income	88
4.1.3 Non-significant demographic variables.....	89
4.2 Relationship Between Generic HRQoL and Audiologic Variables	89
4.2.1 Hearing assistance technology ownership	90
4.2.2 Understanding speech in noise	91
4.2.3 Non-significant variables.....	91
4.2.3.1 Hearing aid ownership	91
4.2.3.2 Severity of hearing impairment.....	93
4.3 Relationship Between Disease-Specific HRQoL and Demographic Variables	94
4.3.1 Income	95
4.3.2 Non-significant findings	95
4.3.2.1 Age	95
4.3.2.2 Sex.....	97
4.3.2.3 Income.....	97
4.4 Relationship Between Disease-Specific HRQoL and Audiologic Variables.....	98
4.4.1 Device ownership	98
4.4.2 BEPTA, WEPTA, SNR loss.....	99
4.4.3 Device ownership	100
4.4.3.1 Discriminating audiometric variables between HA owners and non-owners	101
4.4.3.2 Discriminating demographic variables between HA owners and non-owners	102
4.4.3.3 HRQoL variables discriminating HA owners and non-owners	102
4.4.3.4 Significant variables discriminating HA owners and non-owners.....	103
4.4.3.5 Significant variables discriminating HAT owners and non-owners	103
4.5 Clinical Implications	105
4.6 Limitations and Directions for Future Research	107
4.7 Conclusion.....	109
References.....	110
Appendix A – Information Sheet.....	128
Appendix B – Participant Information Form	130

List of Abbreviations

dB HL	Decibel Hearing Level
dB SNR	Decibel Signal to Noise Ratio
HAs	Hearing Aids
HHIA	Hearing Handicap Inventory for Adults
HHIE	Hearing Handicap Inventory for Elderly
HI	Hearing Impairment
HRQoL	Health-Related Quality of Life
Hz	Hertz
ICF	International Classification of Functioning, Disability, and Health
kHz	Kilo-Hertz
NFD	National Foundation for the Deaf
NIH	National Institutes of Health
PTA	Pure-tone Average
QuickSIN	Quick Speech In Noise
SF36	Short Form 36
SIP	Sickness Impact Profile
WHO	World Health Organization
WHO-DAS II	World Health Organization Disability Assessment Schedule 2.0
NZ	New Zealand

List of Figures

Figure 1. The WHO-ICF biopsychosocial model	22
Figure 2. Distribution of age of participants ($N=126$).	66
Figure 3. Ancestral identifiers for the total sample.....	66
Figure 4. Reported sex characteristics for the total sample.	67
Figure 5. Reported education levels for total sample.	67
Figure 6. City size for total sample.....	68
Figure 7. Sexual orientation for total sample. Includes non-reporters.....	68
Figure 8. Hearing aid ownership for total sample.....	69
Figure 9. Hearing assistance technology ownership for total sample.....	69
Figure 10. Type of HAT used by HAT owners. Note: some people owned more than one type of HAT.	70
Figure 11. Hearing aid and HAT ownership for total sample. Includes non-reporters.....	70

List of Tables

Table 1. Classifications of Hearing Impairment	15
Table 2. Age, relationship length, hours worked per week, and income for the total sample.	65
Table 3. Continuous audiologic variables for participants with measurable thresholds at all PTA frequencies ($N=118$).....	71
Table 4. HRQoL for entire sample.	71
Table 5. Pearson correlations between generic HRQoL measures and continuous demographic measures.....	73
Table 6. ANOVA for categorical demographic variables for generic HRQoL and ancestry. .	73
Table 7. ANOVA for categorical demographic variables for generic HRQoL and sex.	73
Table 8. ANOVA for categorical demographic variables for generic HRQoL and education.	73
Table 9. ANOVA for categorical demographic variables for generic HRQoL and city size. .	74
Table 10. ANOVA for categorical demographic variables for generic HRQoL and sexual orientation.	74
Table 11. ANOVA comparing generic HRQoL variables for HA owners and non-owners. ..	75
Table 12. ANOVA comparing generic HRQoL variables for HAT owners and non-owners.	75
Table 13. Pearson correlations between generic HRQoL measures and continuous audiometric measures.....	75
Table 14. Pearson correlations between disease-specific HRQoL measures and continuous demographic variables.	77
Table 15. ANOVA for categorical demographic variables for disease-specific HRQoL and ancestry.	77
Table 16. ANOVA for categorical demographic variables for disease-specific HRQoL and sex.	77
Table 17. ANOVA for categorical demographic variables for disease-specific HRQoL and education.	77
Table 18. ANOVA for categorical demographic variables for generic HRQoL and city size.	78
Table 19. ANOVA for categorical demographic variables for generic HRQoL and sexual orientation.	78

Table 20. ANOVA comparing disease-specific HRQoL between HA owners and non-owners.	79
Table 21. ANOVA comparing disease-specific HRQoL variables between HAT owners and non-owners.	79
Table 22. Pearson correlations between disease-specific HRQoL measures and continuous audiometric variables.	79
Table 23. Discriminant analysis for hearing aid ownership.	81
Table 24. Discriminant analysis for HAT ownership.	83

Chapter One: Introduction

1.1 Overview

Hearing impairment (HI) can profoundly reduce a person's ability to receive and understand speech signals, especially in the presence of background noise. Thus, the ability and experience of effective communication becomes altered by the presence of HI. The impacts of HI extend far beyond this reduced understanding of spoken messages and indeed, beyond any particular conversation; as the ability to communicate becomes altered by HI, interpersonal relationships can become severely affected (Slawinski, Hartel, & Kline, 1993). This communicative disability, caused by HI and experienced by the person living with HI and those around them, can lead to withdrawal from social activities (Arlinger, 2003) and many other negative psychosocial outcomes. Furthermore, HI can impact negatively upon the health and quality of life (QoL) of the hearing impaired individual. Research conducted overseas has explored and provided some insight into what ways a person living with HI experiences the impact on their perception of both generic, and disease-specific, health-related quality of life (HRQoL). It is unknown how HI impacts adults living with HI in the context of Aotearoa/New Zealand (NZ).

Hearing impairment affects a large number of individuals globally. In 2005, the World Health Organization (WHO) reported that approximately 642 million people worldwide were living with hearing impairment (HI) (World Health Organization, 2006). With a prevalence of nearly 10% of the global population, HI is one of the most prevalent chronic human health conditions worldwide (Danermark et al., 2010). Global prevalence as reported by the WHO is similar to numbers reported in NZ, where it has been estimated that anywhere from 10% (Greville, 2005) to 17% of the population are living with some form and degree of HI ("National Foundation for the Deaf," n.d.). A number of factors related to both

HI definition and prevalence reporting affect these estimates, however, it is clear that the number of people reporting living with HI is increasing. The number of people reporting HI has increased 3.6% between 1984 and 2008 in the USA; this is equivalent to the HI population increasing at 160% of the growth rate of the US population in general (Kochkin, 2009). This may be due to both increasing life expectancy in the USA, as well as the increasing number of people in the baby boom generation entering later stages of life. As life expectancy lengthens, an increase in people with age-related HI (presbycusis) is expected. An increase in HI is also expected due to population increases, particularly in developing countries where higher risk factors for HI are present (Danermark et al., 2010).

The negative psychosocial consequences for individuals living with HI are varied, and have been well documented in the literature. Amongst the more common consequences of HI are difficulties with communication, social and emotional isolation, greater dysfunction for physical and mental health, and a negative impact on perception of overall QoL (Chia et al., 2007; Dalton et al., 2003; Keller, Morton, Thomas, & Potter, 1999; Mulrow et al., 1990; Strawbridge, Wallhagen, Shema, & Kaplan, 2000). HI can also have negative consequences in the workforce (Jennings & Shaw, 2008). Difficulty with communication can negatively impact relationships with the hearing impaired person's significant others, and in family life in general (Tye-Murray, 2009). Furthermore, adults living with HI have higher reported levels of depression, anxiety, interpersonal sensitivity, and hostility (Monzani, Galeazzi, Genovese, Marrara, & Martini, 2008). More recently, a longitudinal study of over 12,000 adults in Canada found HRQoL measures identified hearing deficit to be one of two statistically significant predictors of risk of mortality for those both under, and over, 60 years of age (Feeny et al., 2012).

Previous studies exploring perception of QoL for people living with HI have established a trend in variables that may have an impact on perception of quality of life. However, there are very little QoL data on the consequences of HI for individuals living in NZ. This study aims to explore current perceptions of generic HRQoL and disease-specific HRQoL for adults living with any type, configuration, or degree of HI in NZ. Perception of QoL is influenced by many factors. This study aims to explore if and how these various factors are related to perception of QoL, and to compare these results with results from studies of this nature previously conducted overseas. Furthermore, this study aims to identify variables discriminating hearing aid owners from non-owners, and owners of hearing assistance technology from non-owners.

1.2 Hearing Impairment

1.2.1 Overview

The degree to which one is able to detect the sounds of their environment has a direct impact on their experience of that environment, and an impact on how relationships are formed and maintained within that environment. In terms of communication and social engagement, the ability to detect and comprehend speech can have a particular and important influence on the formation and maintenance of interpersonal relationships. Impairment in detecting and comprehending speech sounds can therefore impact the extent to which one may engage with the many aspects requiring speech and language communication within the fabric of NZ society. The impacts of HI are often negative, and can impact upon myriad aspects of life – social, emotional, employment, and health. These negative consequences of hearing impairment can negatively impact a person's perception of QoL (Chia et al., 2007; Mulrow et al., 1990).

Decreased sensitivity to auditory stimuli is caused by abnormalities in the structure and/or function of the auditory system. The abnormalities themselves, also referred to as lesions, can differ in terms of the nature and location of the lesion, as well as aetiology, onset and duration, and severity (Gelfand, 2009). The impairment caused to an individual's hearing is classified in terms of origin, severity, and configuration; these components are determined using a routine audiologic test battery, namely pure-tone audiometry.

Pure-tone audiometry is currently considered the gold standard for determining hearing sensitivity. The purpose of pure-tone audiometry is to identify a threshold of hearing. This threshold is defined as the required decibel hearing level (dB HL) presentation that is detected at least 50% of the time it is presented, that is, the signal is detected at a given intensity level on at least two of three ascending runs (American Speech-Language-Hearing Association, 2005). The current standard for determining this threshold is the Hughson-Westlake technique (1944), as modified by Carhart and Jerger (1959) which uses frequency-specific, pure-tone stimuli in a descending/ascending pattern of 10/5 dB HL respectively. The origin, severity, and configuration of the HI are inferred by the pure-tone audiogram.

The origin of HI refers to the site of lesion. If the site of lesion is located laterally to the spiral ganglion portion of the auditory system, it is considered to be "conductive" in origin. Site of lesion for conductive origins include the middle ear cavity and/or contents, the tympanic membrane, the external auditory meatus, and the pinna. Should an impairment in the process of conducting auditory stimuli arise in these areas, an interruption to the process of conducting auditory stimuli has occurred and therefore a conductive HI is considered present. Examples of abnormalities in the auditory system that may cause conductive HI include otosclerosis, tympanic membrane perforation, aural atresia, ossicular disarticulation (discontinuity), otitis media with effusion ("glue ear"), cholesteatoma, impacted cerumen,

and glomus tumours of the middle ear cavity. HI arising from conductive origins can often be treated via surgical means (e.g. inserting ventilation tubes to drain the effusion following otitis media, removing impacted cerumen, or replacing sclerosed ossicles with prosthesis). In some cases, hearing can improve following surgical intervention; as such HI from a conductive origin is not always considered permanent.

A more permanent origin of HI is when the site of lesion is located medially to the conductive components of the auditory system (i.e. medially from the oval window of the cochlea). This includes the cochlea and spiral ganglion, the VIIIth cranial nerve (the “cochlear nerve,” “acoustic nerve,” or “auditory nerve”), and the central auditory pathway terminating at the auditory cortices. Impairment to hearing due to abnormality within these structures is referred to as a “sensorineural” HI (SNHI). Examples of abnormalities within the cochlea that may cause SNHI include presbycusis (age-related HI), noise-induced hearing loss (NIHL), endolymphatic hydrops, or any third window disorders (such as perilymph fistula, or superior semi-circular canal dehiscence syndrome). Examples of neural (or retrocochlear) abnormalities include Bell’s Palsy, vestibular Schwannoma, neuropathy of the auditory nerve, or lesions in the central auditory pathway. Surgical management of SNHI is possible in some cases (e.g. removing a vestibular Schwannoma), however a HI of sensorineural origin is generally considered to be permanent in nature. A “mixed” HI refers to the presence of both a sensorineural and conductive components of the HI.

Pure-tone audiometry also infers the severity of the HI. Routine audiometric testing establishes thresholds at octave frequencies, starting at 250 Hz and progressing to 8 kHz, where 250 – 500 Hz are considered “low frequencies,” 1 – 2 kHz are considered “mid-frequencies,” and 4 – 8 kHz are considered the “high frequencies” of the typical speech spectrum. The perceptual correlate of frequency is pitch, where any given frequency of a

pure-tone may be perceived as positioned within a musical scale (Moore, 2003). A pure-tone average (PTA) of thresholds at 3 frequencies (3-PTA; 500, 1000, and 2000 Hz) or 4 frequencies (4-PTA; 500, 1000, 2000, and 4000 Hz) is often used to classify the severity of the HI. Alternatively, severity can be classified by taking into account the audiometric threshold at all frequencies tested. An individual's threshold of hearing at any given frequency is obtained using the modified Hughson-Westlake procedure, and is accurate to 5 dB with an 80% confidence level ($SD = \pm 1.28$) (Witting & Hughson, 1940). A common classification system combines Goodman (1965) and Jerger & Jerger (1980) classifications for HI severity, which is as follows: frequencies at which thresholds are 20 decibels hearing level (dB HL) or below are considered within the normal limits; where thresholds are from 21 – 40 dB HL, the severity of HI is referred to as mild; thresholds between 41 – 55 dB HL indicate a moderate HI; thresholds between 56 – 70 dB HL are considered moderately-severe; thresholds from 71 – 90 dB HL are considered severe, and any threshold greater than 90 dB HL is considered a profound HI. Classifications for normal limits of hearing range from 15 dB (Northern & Downs, 2002) to 25 dB (Goodman, 1965). Original classifications are as summarised in Table 1 below.

Table 1. Classifications of Hearing Impairment

Degree of Loss	Goodman (1965)	Jerger & Jerger (1980)	Northern & Downs (2002)
None	<26	<21	<16
Slight			16-25
Mild	26-40	21-40	26-30
Moderate	41-55	41-60	30-50
Moderately severe	56-70		
Severe	71-90	61-80	51-70
Profound	>90	>80	>70

The configuration of HI refers to the shape of the audiogram, formed by thresholds at each frequency. The configuration of an audiogram can be flat, sloping, precipitously sloping,

corner (where hearing is only present in the low frequencies), cookie-bite, rising, peaked, trough or notched (Carhart, 1945; Lloyd & Kaplan, 1978).

1.2.2 Prevalence

Estimated prevalence of hearing impairment is dependent upon many factors, with exact percentages and numbers varying to some extent in the literature. Prevalence of HI has been repeatedly shown to vary given certain factors, despite variations between reported estimates. One of the major factors affecting prevalence estimates is whether prevalence was determined based on objective measures of HI, or subjective reports of HI. Prevalence also increases as age increases. The percentage of those reported to have HI will also vary as the degree and definition of hearing impairment changes. Location impacts prevalence as well, be it broad comparisons between “first world” countries and “developing” countries, or more minute divisions within a population, such as comparing those over age 65 who are living in nursing homes vs. those who are living in the community.

1.2.2.1 Objective and subjective measures of prevalence

Objective measures of HI, such as audiometric testing, tend to reveal greater prevalence amongst a population than subjective measures, such as self-report of HI. Indeed, pure-tone audiometry performed on a random population sample of over 1,400 people aged 55 and over found that 34% had HI; less than half of that 34% had visited their GP for HI, despite 57% regarding their hearing as poor (Duijvestin et al., 2003).

1.2.2.2 HI and age

Amongst adults, it is well established that the prevalence of acquired HI increases with age. It has been estimated that HI among those aged 18 – 44 is as low as 5.4%, rising to at least 30% amongst people over age 65 (Weinstein, 2000). Using objective audiometric

measures, a more recent study in the USA ($n = 5742$), found that 8.5% of participants aged 20 – 29 ($n = 1458$) had high frequency hearing loss, which was defined as the mean of pure-tone thresholds at 3, 4, and 6 kHz at 25 dB HL or higher. That figure steadily increased (17%, 34%, 53%, and 77%) within each subsequent decade-long age bracket (30-39, 40-49, 50-59, and 60-69, respectively) (Agrawal, Platz, & Niparko, 2008). These figures are inclusive of both unilateral and bilateral HI.

According to census data in NZ, HI is approximately 3.5 times more prevalent amongst those 65 years of age and older, than amongst adults under 65 years (Greville, 2005). Therefore, HI is expected to increase continually as the populations of Western countries continue to age.

1.2.2.3 Degree and definition of hearing impairment

The degree of hearing impairment considered fit for reporting has a profound effect on the reported figures. In some cases, prevalence can more than double when mild HI is included in the percentage. For example, the WHO estimates global prevalence of disabling hearing loss of a moderate classification or greater (>40 dB HL), to be 278 million people. If including mild hearing losses (26 – 40 dB HL), that estimate rises to 642 million people, or just over 10% of the world population at the time, of which 25 million are estimated to be present from childhood (World Health Organization, 2006). Furthermore, the classification system used to denote degree of hearing loss defines the parameters within which HI is considered present. For example, using the Northern and Downs classification system (Northern & Downs, 2002) to define presence of HI within a population would result in larger prevalence estimates than using Goodman's system (Goodman, 1965), due to each classifying the normal limits of hearing thresholds differently (≤ 15 dB HL and ≤ 25 dB HL, respectively) (Table 1). The most recent global prevalence estimate of 642 million people

living with HI of a mild degree or greater, classifies the normal limits of hearing as ≤ 25 dB HL (World Health Organization, 2006).

The definition of hearing impairment, including whether unilateral cases of HI are included in the report of prevalence, plays an integral role in determining reported prevalence of HI. In the previously mentioned study by Agrawal et al. (2008), two definitions of hearing impairment were used. The first was high frequency hearing loss, which was considered present if the mean of pure-tone audiometric thresholds at 3, 4, and 6 kHz was 25 dB HL or greater. The second was speech frequency hearing loss, which was considered present if the mean of audiometric thresholds at 0.5, 1, 2, and 4 kHz was 25 dB HL or greater. If reporting prevalence for HI within the speech frequencies, the figures are much lower than those cited above for the high frequency hearing loss: 3.1%, 5.4%, 15%, 29%, and 49% for ages 20-29, 30-29, 40-49, 50-59, and 60-69 respectively, and inclusive of both bilateral and unilateral hearing impairments. The lower prevalence reflects the effects of age-related HI, which typically causes a high frequency hearing loss in the first instance, and can progress to lower frequencies over time (Schuknecht, 1974).

In NZ, the National Foundation for the Deaf estimates there are approximately 700,000 people in Aotearoa/New Zealand living with some degree of hearing impairment. This translates to roughly one in six, or up to 17%, of the population (“National Foundation for the Deaf,” n.d.). Though the definition and degree of HI is not specified, this prevalence estimate is consistent with data published in other countries; in the United Kingdom, Davis (1989) found approximately 16% of participants aged 17 – 80 had a bilateral hearing loss following audiological assessment (defined as >25 dB HL average across the four audiometric frequencies of .5, 1, 2, and 4 kHz), rising to 25% if unilateral losses are included (Davis, 1989). In the United States, it has been estimated that 16% of those aged 20 – 69 have

HI (Agrawal et al., 2008). These numbers may rise to as high as 46% amongst those over 65 years of age (Cruickshanks, Wiley, & Tweed, 1998; Gates, Cooper, Kannel, & Miller, 1990). However, self-reports of HI in NZ are much lower, with 9.8% (368,600) reported in the 1991/1992 NZ Census (Greville, 2005), rising to 10.3% when estimates include institutionalized individuals. This is similar to the 11.3% reported in the Marke-Trak self-report surveys carried out in the United States in 2008 (Kochkin, 2009).

1.2.2.4 Location of population

Prevalence of HI within a population also varies as the definitions and demarcations of the population's location are adjusted. Location can be defined in broad terms such as a nation state, in general terms such as urban vs. rural regions, and in specific terms such as the type of living environment inhabited by people within a certain age bracket.

Divisions are often made within an age group, especially those over 65. In the over-65 demographic, there is a consistently reported significant difference in prevalence of HI between those who are nursing home residents, and those who are not. This division is made to address the significantly higher prevalence of HI amongst older people living in nursing homes, compared to those living in the community.

Broader population demarcations in terms of reporting per geographical region or nation state have also shown significant differences between populations. These regions are similarly grouped in terms of income level. The highest prevalence of adult HI globally has been reported in the lower-income, geographical regions of sub-Saharan Africa, South and South-East Asia, with lower prevalence of HI reported in high-income regions (Stevens et al., 2013).

1.2.2.5 Division by sex

It has also been reported that prevalence of HI is higher amongst men than women (Agrawal et al., 2008; Gates, Murphy, Rees, & Fraher, 2003; Greville, 2005). Globally, as of 2008, the estimated average of HI amongst males over the age of 15 is 12.2%. For females, this global average is reduced to 9.8% (Stevens et al., 2013). Though it has been posited that the higher prevalence in males may be due to occupational noise exposure (Wallhagen, Strawbridge, Cohen, & Kaplan, 1997), one study ($n = 3,753$) found that even after controlling for occupation and noise exposure, there was still a statistically significantly higher prevalence of HI amongst males than females (Cruickshanks et al., 1998).

1.2.3 Impact of hearing impairment

The consequences of HI on an individual's life are varied, and are not predictable based on audiometric data alone (Erdman & Demorest, 1998). Models such as the World Health Organization's International Classification of Functioning, Disability, and Health (WHO-ICF) (WHO, 2001) provide a useful framework with which some of these consequences can be addressed. Quality of Life (QoL) is also impacted by HI. The components of QoL and the WHO-ICF are separate but related concepts (Hickson et al., 2008). Standardized self-assessment questionnaires can be used to measure the impact of HI on both generic, and disease-specific, QoL.

1.2.3.1 Impact of health conditions

In 2001, the World Health Organization (WHO) introduced the second edition of the International Classification of Functioning, Disability, and Health (ICF), which was endorsed at the Fifty-fourth World Health Assembly in May of 2001 (WHO, 2001). The ICF updated the original International Classification of Impairments, Disabilities, and Handicaps (ICIDH; World Health Organization, 1980). Using a biopsychosocial model of disability, the ICF

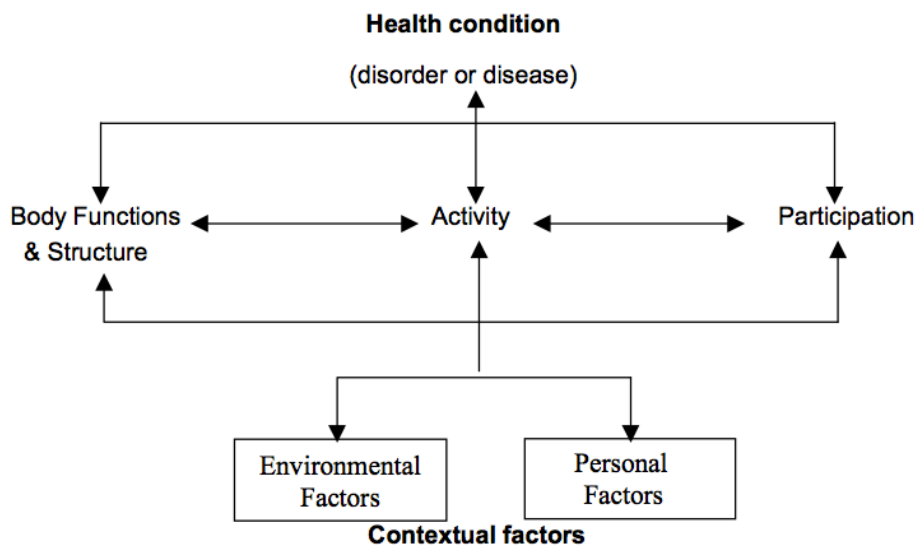
provides a standardized language and a conceptual basis for health, functioning, and disability. The ICF is a multipurpose tool, which can be used to describe, classify, measure, assess, and inform policy in areas related to health, health systems, and disability. This document focuses on the impact of disability, rather than the cause, by recognising the experiences of decrements in health and of disability as universally human (WHO, 2002).

The biopsychosocial (literally the biological, individual, and social) model of disability moves away from relying entirely upon the medical model by integrating with the social model. Under the medical model, disability is viewed as a problem within an individual, caused by a disease or other condition, and which requires treatment in the form of professional medical care. The following diagram shows the unidirectional, linear medical model as endorsed by the WHO between 1980 and 2001, which served as the global international classification system prior to publication of the ICF:

Disease → Impairment → Disability → Handicap

The social model, on the other hand, views disability as social phenomena generated by an unaccommodating environment, thereby requiring a socio-political response within the social environment. By integrating the two models, the ICF avoids the pitfalls inherent in adopting or rejecting wholly one view or the other; though both are valid, neither is adequate (WHO, 2002). The ICF uses the following diagram to represent the nonlinear relationship between the different factors taken into consideration in the biopsychosocial model. This model was chosen with the aim of providing a “coherent view of different perspectives of health from a biological, individual, and social perspective” (World Health Organization, 2001, p. 28):

Figure 1. The WHO-ICF biopsychosocial model



The ICF consists of two parts, each of which has two components. The first part is Functioning and Disability, which includes the components present on the middle line of the diagram above (Body Functions and Structure; Activity, and Participation). *Body Functions* refer to any functions of the body, whether physiological or psychological, and *Body Structure* refers to any of the physical or anatomical components of one's body. A limitation at the level of Body Function or Body Structure corresponds to the term *Impairment* in the previous ICIDH classification system. *Activity* refers to the execution of an action. The negative equivalent, referred to as an *Activity Limitation*, is the difficulty faced by an individual in executing that action. A limitation of activity corresponds to the term *Disability* in the previous ICIDH classification system. *Participation* refers to an individual's involvement in a life situation. The negative equivalent, referred to as *Participation Restriction*, is any restriction faced by an individual when being, or attempting to be, involved in that situation (WHO, 2001). Restrictions to participation were previously termed *Handicap* in the ICIDH (World Health Organization, 1980).

It is well documented that HI can lead to activity limitation and participation restrictions, particularly communication difficulties, cognitive dysfunction, and social and emotional isolation (Arlinger, 2003; Dalton et al., 2003; Mulrow et al., 1990; Stumer, Hickson, & Worrall, 1996). For example, the *health condition* of Meniere's disease (a disease of the inner ear which often causes fluctuations in hearing threshold) leads to the *impairment* of fluctuating hearing loss, causing the *activity limitation* of being unable to distinguish speech in background noise, leading to the *participation restriction* of not attending a social gathering.

The second part of the ICF introduces Contextual Factors, the components of which comprise the bottom row of the diagram above (Environmental Factors; Personal factors). In the biopsychosocial model, the present health conditions interact with contextual factors, leading to the outcomes of disability and functioning. The environment includes social and legal structures, social attitudes, as well as the physical environment. Personal factors refer to components of an individual's life that, although not part of the health condition, may influence an individual's experience of disability (WHO, 2002). These may be demographic factors such as age, sex, education, and social background; alternatively, these personal factors may refer to different coping styles, past and present experiences, character, and behavioural patterns.

The term impairment refers to a problem with the body structure or function. The term disability is an umbrella term, which refers to the impact of the health condition on these functions: impairment of body function, participation restrictions, and activity limitations (WHO, 2002). Here the influence of the social model is apparent; the term *disability* now ventures beyond the body function to include the dynamic interaction between the person and their environment.

1.2.3.2 Measuring the impact of hearing impairment – quality of life

The impact of HI extends beyond participation restrictions and activity limitations, into the more general realm of QoL. QoL has been defined by the WHO as “the individual’s perception of his/her position in life in the context of the culture and value systems in which he/she lives and in relation to his/her goals, expectations, standards, and concerns” (1993).

The National Institutes of Health identify nine domains of influence on QoL (National Institutes of Health, 1993):

- (1) Spiritual
- (2) Psychological
- (3) Cultural
- (4) Philosophical
- (5) Financial
- (6) Political
- (7) Interpersonal
- (8) Temporal
- (9) Health Status

In other words, the general concept of QoL can be encapsulated in the simple sentence, “how good or bad you feel your life to be” (Bradley et al. 1999, p. 80).

1.2.3.3 Measuring the impact of hearing impairment – health-related quality of life

Determining behavioural audiological thresholds, which are the softest sounds a person can detect and respond to, via pure-tone audiometry provides a measure of the degree, origin, and configuration of HI. It is important to note that it is beyond the scope of these thresholds to predict an accurate and nuanced reflection of the subjective experience of

people with HI. Inference of the impact of the severity of HI on a person's life can only be gained via report from the person themselves (Swan & Gatehouse, 1990)

Generic HRQoL

Two main classifications of HRQoL assessments are related to health status: generic and disease-specific HRQoL (National Institutes of Health, 1993). Generic HRQoL instruments measure an individual's perception of their overall HRQoL, without focusing on the impact of any given specific disease, disorder, or treatment. Generic instruments may be sensitive to the presence of HI when domains within the instruments, or questions within those domains, focus on communication and hearing (Chisolm, Abrams, McArdle, Wilson, & Doyle, 2005), but may not be sensitive to intervention or treatment in terms of measuring benefit gained from the use of amplification in adults with HI (Bess, 2000). Several of the most commonly used instruments used to measure generic HRQoL are briefly outlined below.

There are several validated instruments commonly used to measure generic HRQoL in audiology research, each differing in length and domains assessed. One such instrument is the World Health Organization's Disability Assessment Schedule II (WHO-DAS II; World Health Organization, 1999). The WHO-DAS II is a standardized 36-item questionnaire, applicable to both general and clinical adult populations, and with the stated ability to assess all diseases and disorders, over different cultures. The WHO-DAS II assesses six domains, all of which are conceptually grounded in the ICF (World Health Organization, 1999):

- (1) Communication - understanding and communicating
- (2) Mobility - moving and getting around
- (3) Self-care - hygiene, dressing, eating, and staying alone

- (4) Getting along - interacting with other people
- (5) Life activities - domestic responsibilities, leisure, work, and school
- (6) Participation - joining in community activities

Questions assessing communication and hearing fall under the first domain listed above. Audiologic researchers have assessed the psychometric properties of the WHO-DAS II for convergent validity, internal consistency, and test-retest stability for communication, participation, and total scores for older individuals living with adult-onset hearing loss. It was found that domain scores on the WHO-DAS II were moderately and significantly correlated with scores on another common generic HRQoL instrument: the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36; Ware & Sherbourne, 1992). WHO-DAS II domain scores were also moderately and significantly correlated with disease-specific measures: the Hearing Handicap Inventory for the Elderly (HHIE; Ventry & Weinstein, B., 1982), and the Abbreviated Profile of Hearing Aid Benefit (APHAB; Cox & Alexander, 1995) (Chisolm, Abrams, McArdle, Wilson, & Doyle, 2005).

Unlike the relatively short 36-item WHO-DAS II, the Sickness Impact Profile (SIP; (Bergner, Bobbitt, Carter, & Gilson, 1981) contains 136 items, making it one of the longer generic HRQoL instruments available. The developers of the SIP intended the instrument to be reliable and sensitive to low-impact changes to health status that occurred over time (and after healthcare or medical intervention), on QoL, thus rendering it a useful tool for evaluating medical care. The SIP has 12 subscales covering a range of activities of daily living. Some of these subscales can be combined to create the two main components of the SIP: physical (which combines the subscales of mobility, body care and movement, and ambulation), and psychosocial (which combines the subscales of communication, emotional behaviour, social interaction, and alertness behaviour). Furthermore, an overall score can be

calculated, with a higher score indicating greater negative impact of a health condition on QoL (Bergner et al., 1981). Using the SIP, one study has reported a statistically significant improvement in functioning for older adults following the use of amplification (Crandell, 1998b). However, this study had a relatively small sample size ($n = 20$), all of whom had reported significant functional disturbance on the SIP prior to the provision of amplification, which may have increased the probability of finding a significant improvement between baseline and the three and six month follow-ups (Bess, 2000).

The Self-Evaluation of Life Function (SELF) (Linn & Linn, 1984) is comprehensive self-report generic HRQoL instrument for use with adults age 60 and older. It is relatively short in length, comprised of 54 items measuring six different areas of functioning. The SELF can be scored on a global scale (from 54 to 216 points), with a higher score indicating greater dysfunction. Alternatively, the scoring can be broken down into the following six subscales: physical disability, personal control, depression, social satisfaction, self-esteem, and symptoms of aging. The SELF is one of the generic HRQoL measures that may not be sensitive to changes to QoL following audiological intervention for people with HI (Mulrow et al., 1990).

The EuroQol-5D (EuroQol Group, 1990) is a self-report generic HRQoL instrument with two parts, each consisting of one page. The first part has three questions for each of five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. The second part of the EuroQol-5D requires the subject to report a rating of general health on a visual analogue scale, with a range from 0 to 100 where a lower value corresponds with a worse overall rating of their health condition. The EuroQol-5D showed a statistically significant improvement in the anxiety/depression dimension following audiological intervention in the form of hearing aid provision in a 2002 study (Joore, Potjewijd,

Timmerman, & Anteunis, 2002). However, this was not replicable in a later study, which did not show improvement in any of the five EuroQol-5D dimensions following provision of hearing aids (Metselaar et al., 2009).

The Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36; Ware & Sherbourne, 1992) is also widely used in audiology research. This generic Health-Related Quality of Life (HRQoL) instrument does not measure the effects of hearing impairment on an individual's life, but rather, aims to measure overall perception of HRQoL. The SF-36 consists of two component scales: a physical component scale (PCS), which provides four subscale scores on components of physical health, bodily pain, and role limitations due to physical health problems, and general health perceptions; and a mental component scale (MCS), which provides four further subscale scores on components of mental health, vitality, role limitations due to mental health problems, and social functioning (Abrams & Chisolm, 2009). Responses on each of the subscales can range in score from 0 – 100, corresponding with lowest physical or mental function to highest. The means scores for all subscales are standardised to 50, with a SD of 10 (Abrams & Chisolm, 2009).

Disease-Specific HRQoL

Disease-specific HRQoL instruments focus on a particular disease or health condition, to determine the impact that specific disease has on the individual's perception of well-being and functioning (Chisolm et al., 2007). Unlike generic instruments, disease-specific instruments tend to be sensitive to audiology intervention (Abrams & Chisolm, 2007). There are over 30 hearing-related, disease-specific HRQoL instruments available. Those commonly used in published audiology research are explored below.

The Hearing Handicap Inventory for the Elderly (HHIE; Ventry & Weinstein, B., 1982) and the Hearing Handicap Inventory for Adults (HHIA; (Newman, Weinstein, Jacobson, & Hug, 1991) are widely used self-assessment disease-specific measurement tools in audiology research (Chisolm et al., 2007). These instruments measure the perceived psychosocial effects of hearing impairment on specific areas of a person's life. The HHIE was developed to be used with non-institutionalized subjects aged 65 and over. The HHIA, which incorporates occupational and leisure questions, was developed for use with working adults under age 65. The HHIE and HHIA have high levels of internal consistency and test-retest reliability (0.95) and validity (0.89; Weinstein & Ventry, 1986; Newman et al., 1991). The HHIE and HHIA are one of the more common tools used to measure disease-specific HRQoL.

Both the HHIE and HHIA consist of 25 questions, which are comprised of two subscales. The emotional subscale consists of 13 questions which address the impact of hearing loss on the emotional domain of a person's life. The second subscale, which addresses the perceived impact of HI on function in social situations, consists of 12 questions. A "yes" response to any of the 25 items adds four points towards the total score, a "sometimes" adds two points, and a "no" adds zero points, for a maximum total of 100 points (Ventry & Weinstein, 1982).

The Communication Profile for the Hearing Impaired (CPHI; Demorest & Erdman, 1987) uses 125 items to focus on four areas of communication: strategies, performance, environment, and personal adjustment. The CPHI was developed with the purpose of determining the rehabilitative needs of service members on active duty at the Walter Reed Army Medical Centre. The authors emphasise the importance of understanding variables beyond auditory factors for successful management of hearing impairment. The CPHI can

assist in developing the understanding of how the adjustment to hearing impairment is affected by psychosocial, environmental, and behavioural variables (Erdman & Demorest, 1998).

Some common disease-specific HRQoL measures used within audiology research and practice focus specifically on the impact of hearing aids on QoL. These instruments include the International Outcomes Inventory – Hearing Aids (IOI-HA; Cox & Alexander, 2002), and the Abbreviated Profile of Hearing Aid Benefit (APHAB; Cox & Alexander G.C., 1995), and the Glasgow Hearing Aid Benefit Profile (Gatehouse, 1999). The impact of hearing aid use on QoL is discussed further in the following section.

1.2.4 Effect of intervention on the impact of hearing impairment

Significant prevalence, combined with the well-documented negative impacts upon perception of both generic and health-related QoL, has prompted the development of a number of interventions aimed at reducing the negative impacts of HI. Development of devices and techniques used for intervention range from surgical implantation of electrodes into the cochlea (cochlear implants), to hearing aids, to hearing assistance technology, to rehabilitative and training programs. Audiology rehabilitation (AR), particularly synthetic training focused on active listening strategies, has also been shown to effectively improve psychosocial functioning (Sweetow & Palmer, 2005). These types of intervention, especially use of amplification via hearing aids, have repeatedly been associated with more positive perception of QoL as measured by disease-specific tools such as the HHIE (Ventry & Weinstein, 1982), and the HHIA (Newman et al., 1991). However, with only 40% of people with moderately-severe HI or worse and less than 10% of people with mild HI adopting

hearing aids (Kochkin, 2009), researchers and practitioners alike have an interest in determining the factors influencing adoption of and benefit gained from intervention.

Hearing assistance technology (HAT) refers to any technological device used to “facilitate reception and identification of speech and non-speech signals” (Thibodeau, 2009, p.305). The assistance provided by this device can be in the form of amplification such as an amplified telephone ringer and/or handset, induction loop systems, telecoil, public address systems, and personal amplification systems including hearing aids and cochlear implants, and technology that sends amplified signals to hearing aids or cochlear implants, such as array microphones or FM systems. The latter tend to amplify a desired speech signal to create a greater SNR, thus may be preferable to hearing aids for some users (Pruitt, 1990). The assistance may also be in a visual format, such as CapTel, television captions, flashing doorbells, smoke alarms, and telephones. Alternatively, vibratory signals can alert a person with HI of presence of a stimulus such as an alarm clock, or canines can alert people to auditory signals such as doorbells. Previously, HATs were referred to as “assistive listening devices” or ALDs. The term HAT is preferable to ALD, as the latter fails to encompass technology that provides the subject with non-auditory means of reception and identification of signals that do not require listening (Thibodeau, 2009).

Though they are technically a type of HAT, hearing aids are often referred to in their own category of intervention quite separate from other HATs. A hearing aid is a device that provides amplification of sounds reaching the onboard microphone to the wearer. The frequencies to which the hearing aid provides amplification, and the amount of gain added, determined by the audiogram and user report and are generally programmed via computer software. To provide amplification to the wearer, each hearing aid requires the following

basic components: microphone, pre-amplifier, amplifier, volume control, level detector, receiver, and battery.

Aside from simply amplifying sounds, the inclusion of compression and, more recently, wide dynamic range compression (WDRC), allows the hearing aid to be programmed to contain amplified sounds within the user's dynamic range. The dynamic range is the range of audible sounds between the threshold of a person's hearing to the threshold of pain, or uncomfortable loudness level (UCL). A reduced dynamic range is present in cases of sensory hearing impairment and occurs because of the raised threshold. A reduced dynamic range can also be a product of a lowered UCL caused by recruitment of the inner hair cells in response to incoming sounds. The compression within a hearing aid allows soft sounds to become louder, while ensuring louder sounds do not breach the UCL. Thus, a hearing aid is able to assist the wearer in terms of amplifying sounds, and if compression is present, ensuring those sounds are both audible and not uncomfortable. Alternatively, if the hearing impairment is conductive in origin, the dynamic range is less likely to be reduced in size than to simply be shifted to higher input levels.

Hearing aids can also include many other features, including digital noise reduction, directional microphones, frequency lowering, feedback suppression, wireless connectivity, and data logging. Despite a hearing aid's ability to provide amplification at certain frequencies, they cannot improve reduced frequency selectivity (which is often present in cases of SNHI) for the wearer. Hearing aids may provide better understanding of speech signals in background noise for some users in certain situations, however the hearing aid itself cannot overcome the phenomenon referred to as the upward spread of masking, wherein due to the physiology of the basilar membrane, lower frequency sounds tend to mask out higher frequency sounds more than the reverse. A significant amount of meaning is contained

within the higher frequencies of speech, and it is often at these frequencies that HI is present. This is especially true in cases of presbycusis. Conversely, background noise generally tends to carry with it the weight of lower frequency sounds.

1.2.4 Factors influencing intervention

On average, a person who consults for services has been aware of a decline in their hearing for 10 years (Davis, Smith, Ferguson, Stephens, & Gianopoulos, 2007). On average, another seven years will pass before those who will adopt hearing aids do so (Kochkin, 2009) and even then, only 20 – 25% of the population with HI will do so (Kochkin, 2005; Popelka et al., 1998). The decision to seek audiologic intervention (including both consulting for services and/or rehabilitation including hearing aid adoption) has been shown to be influenced by a number of factors. Researchers have explored audiologic, demographic, social, and self-report measures in those who do and do not seek audiologic intervention.

1.2.4.1 Audiologic factors

Amongst the audiologic factors explored in the literature are degree of hearing impairment (Garstecki & Erler, 1998; Humes, Wilson, & Humes, 2003; Swan & Gatehouse, 1990), and better-ear (Helvik, Wennberg, Jacobson, & Hallberg, 2008) or worse-ear hearing threshold (Swan & Gatehouse, 1990). It has also been found that a greater dB SNR loss causing a reduced ability to hear and understand words in background noise is associated with a higher hearing aid adoption and use rate (Robertson, Kelly-Campbell, & Wark, 2012). The relationship between audiometric data and decisions regarding intervention has been explored both in terms of consulting for services, and in terms of adopting hearing aids. Audiologic rehabilitation beyond amplification has also been shown to be effective in reducing perception of the impact of HI (Sweetow & Palmer, 2005) and improving quality of

life (Preminger & Yoo, 2010), however, audiologic rehabilitation was beyond the scope of this study.

Audiometric data and consulting for services

Insofar as the decision to consult for audiological services is concerned, a study by Swan and Gatehouse (1990) explored different factors between those hearing impaired individuals who consulted for services ($N=269$), and those who did not seek management ($N=286$). Audiologic factors present amongst those who sought intervention were a) a greater degree of hearing impairment in the worse ear, and b) significantly less ability to understand speech. Other studies have found that there may not significant differences between the pure-tone thresholds of those who sought audiologic intervention and those who did not (Duijvestin et al., 2003; Garstecki & Erler, 1998), but the perception of the degree of HI is more prevalent amongst those seeking intervention (84%), than those not seeking intervention (57%; Duijvestin et al., 2003). Over half of first-time hearing aid owners in the MarkeTrak VIII report stated the perception of deteriorating hearing was a factor leading to adoption (Kochkin, 2009). Perception of the severity of HI has also been cited as an influencing factor of hearing aid ownership (Fino, Bess, Lichtenstein, & Logan, 1992; Kochkin, 1996).

Audiometric data and hearing aid adoption

Insofar as the relationship between degree of HI and the ownership of hearing aids is concerned, there are conflicting data in the literature. This likely reflects the complex relationship between degree of HI and perception of handicap (Robertson et al., 2012), wherein the former cannot predict the latter and wherein measurement and assessment of the experience of HI requires report from the person with HI (Gatehouse, 2001). Some studies have found that pure-tone average (PTA) is not a distinguishing factor between owners and

non-owners (Garstecki & Erler, 1998; Humes et al., 2003; Robertson et al., 2012). More recently, Fischer et al. (2011) reported that a significantly higher rate of hearing aid ownership was found amongst those with worse HI.

Dividing owners and non-owners by certain demographic variables can reveal factors influencing hearing aid ownership. One study found that if the owners and non-owners were divided by sex, both PTA and word recognition ability were worse in females owners than in female non-owners. Female owners also reported less handicap than female owners with similar degrees of HI (Garstecki & Erler, 1998). Another study found that if owners and non-owners were divided by age, that degree of HI older adults was a significant factor for ownership rate, with higher ownership rates amongst those with worse HI, at least in older elderly adults (85 years of age and above; Gussekloo et al., 2003). Further to low ownership rates are the numbers of “in the drawer” hearing aid owners, for whom hearing aids have been purchased but are not worn; approximately 30% of adults with HI who do purchase hearing aids discontinue use in the long run (Gussekloo et al., 2003; Kochkin, 2000). The most commonly reported reasons for not wearing hearing aids after purchase are lack of perceived benefit, overamplified background noise, fit and comfort, and negative side effects (Kochkin, 2000).

1.2.4.2 Demographic factors and hearing aid adoption

The influence of demographic factors on decisions regarding intervention have also been studied. The results from different studies can be contradictory, highlighting the complexity of the relationships therein. For example, the effect of age on hearing aid adoption, Kochkin (2009) reported that hearing aid adoption rates in the United States were the highest amongst those 85 and older. The rate of adoption decreased with decreasing age bracket for those over 18 years of age. Other studies report no impact of age upon adoption

rates (Gussekloo et al., 2003; Helvik et al., 2008; Robertson et al., 2012); this lack of effect is likely due to the relatively narrow range of ages within the study (Robertson et al., 2012).

Financial constraints is an oft reported barrier to acquiring hearing aids with more people (76%) reporting cost as a prohibitive factor in recent years, than 20 years ago (Kochkin, 1993, 2007). Garstecki & Erler (1998) found an interesting contrast between the reported perception of prohibitive costs associated with hearing aid ownership, and reported income level between male and female owners and non-owners. Although both male and female non-owners reported the cost of hearing aids as an important factor, only the female non-owners reported a lower income than female owners. That is, male non-owners reported the same or higher income, on average, than both male and female owners. Another study found a nonsignificant positive correlation between higher income and hearing aid acquisition (Fischer et al., 2011).

Many demographic factors aside from the aforementioned have been studied to assess their influence on the decision of whether or not to pursue rehabilitation. Income level may have less influence upon the decision to use hearing aids for rehabilitation (Gussekloo et al., 2003) than satisfaction with income level (Garstecki & Erler, 1998). A positive family history of hearing impairment (Fischer et al., 2011), being of female sex (Garstecki & Erler, 1998), and higher education level (Fischer et al., 2011) have also been shown to have a positive relationship with hearing aid adoption. One study found that admission of HI may also influence hearing aid adoption, where men who admitted their HI were significantly more likely to adopt hearing aids, than those who denied their HI (Garstecki & Erler, 1998). Some non-adopters report stigma of hearing loss (Wallhagen, 2010), and particularly of hearing aids (Laplante-Levesque, Hickson, & Worrall, 2010) as a reason for non-adoption. Male non-adopters in particular report concern about the stigma of hearing aids (Garstecki & Erler,

1998), as do 40% of all HI non-adopters (Kochkin, 1993). Some studies have also found the social support or pressure of the people around the person with HI, such as friends and relatives, has an impact on intervention decisions (Cox, Alexander, & Gray, 2005; Duijvestin et al., 2003; Fischer et al., 2011). Finally, self-report measures of perceived perception of handicap has also been shown to have a profound effect on hearing aid adoption in particular (Gopinath et al., 2011; Humes et al., 2003),

Perception of handicap and seeking intervention

While the perception of degree of HI is a factor for deciding to consult, the perception of participation restrictions as measured by self-report measures amongst those seeking intervention reported more handicap than those who had similar degrees of HI but who had not sought audiologic intervention (Swan & Gatehouse, 1990). This relationship between self-perception of handicap and hearing aid uptake has also been noted elsewhere (Fischer et al., 2011; Gopinath et al., 2011; Humes et al., 2003). Origin of HI may also affect perception of activity limitation and participation restriction, where one study found that those who had conductive and mixed HI with average thresholds above 40 dB HL reported significantly greater disability (Lutman, Brown, & Coles, 1987). A different study (Fischer et al., 2011) found that two thirds of study participants did not acquire a hearing aid over a 10 year period during which both their hearing and their perception of hearing handicap declined.

Although there is a large amount of literature concerning demographic factors or other influences on hearing aid adoption, there is a dearth of published research focused on demographic factors as they are related to the adoption of hearing assistance technology. The reduced interest in this area could be due to the significant differences in cost between the two types of technology; while hearing aids tend to fall in the region of thousands of dollars, HATs tend to cost in the region of hundreds of dollars.

1.2.5 Benefit of intervention

1.2.5.1 Cochlear implants

The benefit of cochlear implants (CI) reported in the literature is clear, robust, and undisputed. In one study, 100% of adults ($N=10$) reported statistically significant increases in reports of HRQoL at one-year follow-up (Faber & Grontved, 2000); this is echoed elsewhere (Harris, Anderson, & Novak, 1995; Maillet, Tyler, & Jordan, 1995). When HRQoL outcomes are compared between CI and hearing aid users, the CI users report twice as much improvement than hearing aid users, overall (Cohen, Labadie, Dietrich, & Haynes, 2004).

1.2.5.2 Hearing aids

The benefit of amplification on QoL is clear and robust when measured with disease-specific HRQoL instruments (Chisolm et al., 2007). This benefit has been shown to be sustained for at least one year after baseline in the social, emotional, and communication domains following intervention with hearing aids (Mulrow, Tuley, & Aguilar, 1992). Though amplification has also been associated with improvement on generic HRQoL measures (Joore et al., 2002; Mulrow et al., 1990), particularly the PCS of the SF36 (Chia et al., 2007), the evidence has not been strong enough to support a conclusion when effect sizes for within-subject effects are taken into account (Chisolm et al., 2007). Use of hearing aids has also been correlated with reduction in measures of depression (Acar, Yurekli, Babademez, Karabulut, & Karasen, 2011; Boi et al., 2012; Cacciatore et al., 1999; Goorabi, Hosseinabadi, & Share, 2008; Metselaar et al., 2009; Mulrow et al., 1990).

1.2.5.3 Hearing assistance technology (HAT)

Two studies in particular have focused on HAT as separate to hearing aids within a population of study participants, looking particularly at the impact of HAT adoption on HRQoL; to date there is no conclusive evidence that HAT usage has a positive impact on

HRQoL measures, particularly report of handicap. However, there are a wide range of HAT devices available for use, and more systematic research is needed to establish whether or not there are relationships between ownership of any type of HAT and both generic and disease-specific HRQoL.

In 1996 Jerger and colleagues (Jerger, Chmiel, Florin, Pirozzolo, & Wilson) published an article for a study involving 180 elderly persons (100 of whom were already hearing aid users and whose ages ranged from 60 – 96 with a mean age of 74.3, and 80 of whom were not hearing aid users, and whose ages ranged from 60 – 84 with a mean age of 72), to which one of four conditions were randomly assigned: no intervention, hearing aids only, hearing assistance technology (remote microphones) only, and both hearing aids and hearing assistance technology. Audiologic (pure-tone, speech, and immittance audiometry) and HRQoL (HHIE; Ventry & Weinstein, 1982) measures were taken after 6 weeks; the outcomes of the three conditions in which intervention was present showed statistically significant increases in speech understanding and in decreases self-perceived handicap. The authors have noted there was also a statistically significant reduction in self-perceived handicap in the group that did not receive any intervention, and that there is no statistically significant difference in outcomes of any of the four groups (Jerger et al., 1996).

Yueh and colleagues (2011) also randomly assigned three different amplification strategies to three groups of 15 – 16 participants. A fourth group received no intervention (age range 52 – 85, mean age 67 years). The three states of amplification assigned were: hearing assistance technology (age range 53 – 79, mean age of 66.6 years), conventional hearing aids without directional microphones (age range 53 – 82, mean age 72.1), and programmable hearing aids with directional microphones (age range 50 – 86, mean age 68.5). The authors also used the HHIE (Ventry & Weinstein, 1982) to measure handicap at baseline,

at one month, and at three months. Two conditions (control and ALD) showed no significant differences on HHIE scores between baseline and three month follow-up; both groups that had been assigned hearing aids showed statistically significant reductions in their perception of handicap. The group with programmable hearing aids reported the largest reduction in handicap (Yueh et al., 2011). The results from these two studies suggest HAT use has no significant impact on the perception and reporting of handicap as measured by the HHIE. It has also been found that use of HATs (FM systems, in particular) did not lead to a significant improvement of HRQoL measures other than self-perceived handicap (CPHI; Demorest & Erdman, 1987). For that study, participants ranged in age from 20 to 70 years, with a mean age of 39..

1.3 Hearing Impairment and Quality of Life

A succinct and simple definition of Quality of Life, as previously mentioned, is “how good or bad you feel your life to be”(Bradley et al., 1999), but there is no single undisputed definition (Hallberg, Hallberg, & Kramer, 2008) or instrument to measure it. Health status, along with the various factors previously mentioned, has an influence on perception of QoL (National Institutes of Health, 1993). Health, a term defined in 1948 by the WHO and not amended since, can be thought of “not merely the absence of infirmity and disease,” but as the “state of complete physical, mental, and social well-being” (WHO, 1948).

Studies from overseas have shown that perception of HRQoL is negatively impacted by HI (Dalton et al., 2003; Hickson et al., 2008; Mulrow et al., 1990). The impact of severity of HI on HRQoL was discussed previously. Other factors in combination with HI may also impact perception of QoL. Previous research in the non-HI population has shown that some demographic variables may impact perception of generic and disease-specific HRQoL in the non-HI population. While various factors have been shown to influence perception of

HRQoL in the non-HI population, there is not a large amount of literature focused on variance of perception of HRQoL as a function of the demographic variables present in this study in the HI population. Below is an overview of factors previously shown to influence HRQoL. Disease-specific information is included where available.

1.3.1 Age

Studies conducted both overseas and in NZ have shown that scores on both the PCS and MCS of the SF-36 are affected by age. Recall PCS and MCS scores can range from 0 – 100 and have been standardised to a mean of 50. Higher PCS scores indicate better HRQoL in the physical domain, whereas lower PCS scores indicate worse HRQoL in the physical domain. Age tends to be negatively correlated with PCS score. That is, the general trend shows that as people get older, they report increasingly lower scores on the questions relating to physical function on the SF-36. The Taking the Pulse survey ($N=7862$) in NZ used the SF-36 to find mean MCS and PCS scores for several age brackets (Ministry of Health – Manatū Hauora, 1999). The highest mean PCS scores in NZ as measured by that survey were 52.9 (men) and 52.2 (women). These scores were found in the 15 – 24 age bracket. These scores decreased as age bracket increased, and scores steadily declined in each increasing age bracket, resting at a low of 38.7 (men) and 39.4 (women) for those aged 75 and older (Ministry of Health – Manatū Hauora, 1999). These results are similar to those in Australia ($N=5,817$ men, $N=6503$ women), where mean scores for both sexes had a high of 53.23 in the 18-25 age bracket, decreasing to 35.85 for those 75 and older, with women reporting a slightly lower overall PCS mean score (48.97) than men (49.49) (Butterworth & Crosier, 2004). There is a similar trend seen in the normative data from Canada, where mean PCS scores also show a decrease in each age bracket. Men aged 25-34 had a mean score of 53.5, decreasing to 43.7; women aged 25-34 had a lower mean score of 52.4, decreasing to 40.9 for those aged 75 and older (Hopman et al., 2000).

For the MCS, the opposite trend is present to a certain extent. That is, as age increases, scores on the MCS also increase. This increase in scores tends to peak in the fourth age bracket (65 – 74 years of age), then a slight decrease is seen in those aged 75 and over. In NZ, males between 15 – 24 reported a mean score of 50.2 on the MCS increasing to a high score of 53.8 in the 65 – 74 age bracket, then the slight decrease is seen to 52.9. For women, the scores were 46.1, 51.9, and 51.5 for the respective age brackets (Ministry of Health – Manatū Hauora, 1999). This trend is also present in Australia (48.26 for those 18 – 25 years of age, peaking at 52.92 in the age 65 – 74 bracket, and decreasing to 51.31 for those 75 and older; Butterworth & Crosier, 2004). A similar trend is generally present in Canadian normative data, although the associated decrease for the highest age bracket is not observed for men or women. Men reported MCS scores of 51.7 for the 25 – 34 age bracket, reaching a high of 54.9 in the 75+ age bracket. Women's mean MCS scores were 48.6 for those 25 – 34 years of age, reaching 54.3 for those 75 years of age and older; (Hopman et al., 2000).

The relationship between age and the component subscales of the SF-36 in the general population are neither surprising nor particularly illuminating. When HI is taken into consideration, the overall relationship between age and HRQoL becomes more complex. As previously discussed, age also has a relationship with HI, where prevalence and severity of HI tend to increase as age increases.

Age can also impact the perception of handicap caused by HI. For example, Gordon-Salant and Fitzgibbons (1994) found a negative correlation between age and perception of handicap. In that study, younger participants tended to report greater handicap than did older participants, despite the younger participants having equal or better hearing than the older participants. One possible explanation for this relationship is that as younger adults tend to be working and therefore in potentially demanding social circumstances on a regular and

frequent basis, any impairment to their hearing has an arguably greater impact upon their daily living, and more frequent and pressing situations in which HI is noted. Indeed, effective communication in work and work-like situations may be rated as the most important arena in which to possess the ability to effectively communicate (Garstecki & Erler, 1999).

1.3.2 Relationship status

A recent investigation by Kelly-Campbell and Atcherson (2012) examined the effect of several variables on the perception of HRQoL for adults with HI. They found that people in committed relationships ($N=80$) reported less hearing handicap associated with both the Emotional and Social/Situational subscales of the HHI, than those who were not in committed relationships. Adults identifying as lesbian, gay, bisexual, or transgendered (LGBT; $N=83$) who were also in committed relationships also had higher scores on the Mental component scale of the SF-36 than those who were not in committed relationships. Thus, for this group of adults, both generic and disease-specific HRQoL was affected by their relationship status. A committed relationship with a supportive partner can provide the adult with HI support and assistance with communication (Miller, 1983; Scarinci, Worrall, & Hickson, 2008; Wallhagen, 2010) which may lessen the impact of perceived hearing handicap, and the impact on HRQoL.

1.3.3 Hours worked per week

The effect of labour force status (employed full-time, employed part-time, unemployed, or not in the labour force) on perception of HRQoL as measured by the SF-36 in NZ shows a clear trend in terms of MCS and PCS scores. The highest PCS scores for both men and women are for those in full-time employment, followed by those in part-time employment. For men, those who were retired had higher PCS scores than those who were of working age but unemployed; the reverse was true for women. A similar trend was present in

the MCS scores for men. For women, the MCS scores were highest for those in full-time employment, decreasing for those who were unemployed and employed part time, and finally those who were retired (Ministry of Health – Manatū Hauora, 1999).

HI has also been shown to have an impact on employment status, and hours worked per week. For example, a cross-sectional relationship has been found between employment and HI in terms of hours worked per week. That is, men with HI were less likely to be in full-time employment than men without HI therefore directly impacting income levels (Dalton et al., 2003).

1.3.4 Income

In NZ, income has a strong relationship with health status as measured by the SF-36. For both the MCS and PCS, a consistent increase in scores is seen as income brackets are increased. This indicates better quality of life, and is true for both age standardised and unstandardised means, and for both men and women, for nearly all income brackets. This trend is generally present for both Māori and Pākehā (Ministry of Health – Manatū Hauora, 1999). As mentioned above, income is also related to, and affected by, other demographic factors such as HI and hours worked per week.

1.3.5 Ancestry

As previously mentioned, ancestry is related to HRQoL amongst the non-HI population and, furthermore, is linked to other demographic factors that are also correlated with HRQoL, such as level of income. While ancestry has not been a highly studied variable in communication disorders research, there are some data for the relationship between ancestry and generic HRQoL measures in NZ. The Ministry of Health divided ancestry into four categories for their Taking the Pulse survey: European/Pākehā ($N=5,359$), Māori

($N=1,245$), Pacific ($N=601$), and Other (including “New Zealander” responses) ($N=240$). The number of respondents reporting their ethnic identity as “New Zealander” increases each survey. A continuation of this trend may decrease the ability for these surveys to identify ethnic diversity and, furthermore, address health inequalities faced by certain ethnic subsections of the population (Ministry of Health – Manatū Hauora, 2010).

The relationship between HRQoL and ancestry, by sex, as recorded using the SF-36 in the Taking the Pulse survey is as follows. For men on both the PCS and MCS, the Other category scored highest, followed by European/Pākehā. Pacific peoples reported the next highest scores on the PCS, followed by Māori. On the MCS, Māori reported higher mean scores than Pacific peoples. For women, the PCS scores were highest for Other, followed by European/Pākehā, Māori, and Pacific peoples. On the MCS, European/Pākehā women scored highest, followed by Pacific peoples, Other, and then Māori.

1.3.6 Sex

As reports of generic HRQoL can be directly affected by age and relationship status, so too can they be affected by the sex of respondents. In the example mentioned in the age subsection above, women tended to report lower scores on both the PCS and MCS scales in nearly all age brackets in NZ, Australia, and Canada. Perception of disease-specific HRQoL amongst the HI population can also be affected by sex (men: $N=159$; women: $N=142$), as measured using the CPHI (Garstecki & Erler, 1999). That study found that women tended to have a greater willingness to admit communication problems caused by their HI; in other words, they were less likely to deny the impact of their HI. Women were also tended to place more importance on effective communication, so it is not surprising that they were also significantly more likely to use nonverbal communication strategies to supplement their communication when in situations where it was difficult to hear. In placing greater

importance on communication, and being less prone to denying the presence of impairment to communication, means women may be more aware of the impact of HI on their lives. Indeed, women in this study also reported significantly greater negative emotions, including anger and feelings of stress, in relation to the negative impact of HI on their communication, than men.

The impact of sex upon HRQoL is especially complex, as both sex and health status in NZ is inextricably and indisputably woven into a hierarchy of socioeconomic factors such as income, which are furthermore impacted by ancestry. The most recent Income Survey conducted by Statistics New Zealand – Tatauranga Aotearoa has been reported for the June 2013 quarter. There is still a significant disparity in earnings when divided by sex in NZ; the average weekly income from all sources for men in paid employment who took part in the survey was \$1,186, ($N=1,169.6$) and \$851 for women ($N=1018.4$). If sex is then divided by ancestry, men of European ancestry had an average weekly income of \$1,264. For men, this weekly average was affected by ancestry, decreasing in the following order: “Other ethnicity” (includes “New Zealander” responses); Māori, Middle Eastern, Latin American, and African; Asian; and resting at \$857 for Pacific men. The ancestral order does not change when looking at women, but the numbers are lower (from \$863 decreasing to \$755).

Since sex, ancestry, and income are highly associated with each other, and since other demographic factors are also related to each of those, it is necessary to understand the nature by which these demographic factors are connected and may affect perception of HRQoL when discussing any given factor. The impact of income on HRQoL is explored in the following section.

1.3.7 Level of education

No known studies have been published that explore the perception of HRQoL as a function of level of education amongst the HI population. However, in the non-HI population at least, level of education may have a relationship with the PCS subscale of the SF-36. The Taking the Pulse survey conducted by the Ministry of Health – Manatū Hauora found that an increase in quality of life is reported as bracket of education level completed increases. That is, people in NZ who have not completed any educational qualifications report lower PCS scores than those who finished school or post-school only, and those reporting the highest PCS scores fall within the school and post-school qualifications. This trend is present for both men and women, and both Māori and non-Māori, and both with age standardised and unstandardised means. The trend is not present for the MCS, indicating that there is not a significant relationship between level of education and perception of emotional quality of life (Ministry of Health – Manatū Hauora, 1999).

1.3.8 City size

Another demographic factor that can be related to HRQoL is the size and type of area in which a person lives. In 2002/2003, the Ministry of Health – Manatū Hauora conducted a New Zealand Health Survey that included urban-rural health comparisons. Aside from scores on the General Health scale, statistically significant differences in the generic HRQoL scores as measured on the eight subscales of the SF-36 are not present between those who reside in rural and urban areas. Rural males exhibit statistically significantly higher scores on the General Health scale than urban males. Some statistically significant differences are present for men, women, or men and women when the urban and rural areas are further divided into the following categories: main urban, secondary urban, minor urban, rural centre, or true rural areas. For example, both women and men who lived in minor urban centres scored lower in the Role Physical and Bodily Pain scales, than women and men who lived in main urban

areas. Women in true rural areas reported significantly greater scores than women in main urban areas, and men in rural centres reported higher scores on the Mental Health scale than men in main urban areas. No known data is available looking at disease-specific HRQoL for adults with HI in NZ.

1.3.9 Sexual orientation

The American Speech-Language-Hearing Association (ASHA) includes sexual orientation (along with socioeconomic status, ethnicity, educational background, regionalisms, and others) as a source of diversity within the clinical population. Furthermore, ASHA argues that by providing services that are responsive to the linguistically and culturally diverse nature of the clinical population, the clinician remains effective and able to provide quality service (American Speech-Language-Hearing Association, n.d.). People who self-identify as non-heterosexual and/or non-cisgendered often self-identify as members of a community. There are many labels for this community. For the purposes of this study, the term LGBTIQ (lesbian, gay, bisexual, transgendered/transsexual, intersex, and queer) is used.

Despite increasing political and social attention being paid to the rights and lifestyles of members of the LGBTIQ community in recent years, this still remains both a large, and largely understudied, proportion of the population. It is unknown what percentage of people in NZ self-identify as members of the LGBTIQ community. The information is not collected during census. The complexities involved in collecting this information are numerous, including the framing of the question as well as factors influencing how a person answers the question. There are many factors affecting prevalence reporting that are outside the scope of this study. However, there are data collected over the past 18 years by Statistics NZ – Tatauranga Aotearoa indicating the number of same-sex couples who have reported living together. This number has increased steadily over the 18-year period. In Census 2013, 0.89

percent of households surveyed reported same-sex couples cohabitating in the household; this is an increase from 0.7% reported in 2006, 0.6% reported in 2001, which itself was an increase over figures in the 1996 census of 0.41% (Statistics New Zealand - Tatauranga Aotearoa, 1996, 2001, 2006, 2013). It is noted that not all LGBTIQ people cohabit with their partner, or have relationships monogamous in nature as is assumed in the Census, or that those who are in monogamous, cohabitating partnerships would self-identify with one of Statistics New Zealand's three family "types": Opposite-sex couple; male couple; and female couple.

If data for HRQoL for members of the LGBTIQ community is scarce, then adding HI into the search equation reveals even less data. One study conducted in the United States looked at the differences between SF-36 scores for men and women within the LGBTIQ community. That study found that while PCS was not significantly impacted by sex, men tended to score significantly lower on the MCS than women. In terms of disease-specific HRQoL, scores on the social and emotional scales of the HHI were not significantly different between men and women. Furthermore, relationship status had a statistically significant impact on both SF-36 PCS subscale and both scales of the HHI, wherein members of the LGBTIQ community who were in long-term relationships exhibited higher quality of life on those scales (Kelly-Campbell & Atcherson, 2012).

1.4 Study Rationale

As shown in previous sections, HI has been shown to have negative consequences in many areas of a person's life, thus impacting perception of health-related QoL. The prevalence of HI is amongst the highest of chronic nonfatal disabling conditions globally (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006). Many studies have been conducted in various countries overseas to assess the impact of HI on HRQoL amongst local populations.

These studies have been conducted in Australia (Chia et al., 2007; Hickson et al., 2008; Morgan, Hickson, & Worrall, 2002), Iran (Goorabi et al., 2008), Italy (Boi et al., 2012; Cacciatore et al., 1999), Japan (Naramura et al., 1999), the Netherlands (Joore, Brunenberg, Chenault, & Anteunis, 2003; Joore et al., 2002), Sweden (Arlinger, 2003), Turkey (Acar et al., 2011), and the United States of America (Cruickshanks et al., 1998; Dalton et al., 2003; Kelly-Campbell & Atcherson, 2012; Mulrow et al., 1990, 1992). Yet, there is not currently any research reporting on QoL for adults living within the NZ context. This study therefore proposes the examination of several factors within the NZ context that have been shown, elsewhere, to have an impact on perception of quality of life in adults with HI. This research may identify QoL factors in NZ, leading to improved clinical audiological practice.

1.5 Aims and hypotheses

This study has three aims. The first is to examine the perception of QoL for adult individuals with HI in NZ. Using the HHIE (Weinstein, Spitzer, & Ventry, 1986), the HHIA (Newman et al., 1991), and the MOS SF-36 (Ware and Sherborne, 1992) this study aims to test the following hypotheses:

1(a). The perception of generic Health-Related Quality of Life for adults with hearing impairment is related to the following demographic variables:

- (a) age
- (b) relationship length
- (c) hours worked per week
- (d) income
- (e) ancestry
- (f) sex

(g) level of education

(h) city size

(i) sexual orientation

1(b). The perception of generic Health-Related Quality of Life for adults with hearing impairment is related to the following audiologic variables:

(a) hearing aid ownership

(b) hearing assistance technology ownership

(c) better-ear pure-tone average

(d) worse-ear pure-tone average

(e) the ability to understand speech in noise

2(a). The perception of disease-specific Health-Related Quality of Life for adults with hearing impairment is related to the following demographic variables:

(a) age

(b) relationship length

(c) hours worked per week

(d) income

(e) ancestry

(f) sex

(g) level of education

(h) city size

(i) sexual orientation

2(b). The perception of disease-specific Health-Related Quality of Life for adults with hearing impairment is related to the following audiologic variables:

- (a) hearing aid ownership
- (b) hearing assistance technology ownership
- (c) better-ear pure-tone average
- (d) worse-ear pure-tone average
- (e) the ability to understand speech in noise

This second aim of this study is to compare the data collected and analysed for the above hypotheses with the results from research conducted overseas. The final aim of the study is to identify demographic and/or audiometric variables that distinguish between hearing aid owners and non-owners, as well as hearing assistance technology owners and non-owners.

Chapter Two: Method

2.1 A Priori Sample Size Analysis

Before commencing participant recruitment, required sample size was determined using *a priori* sample size analysis. Due to standard use in research, level of significance was set at .05 and statistical power at .80. An effect size of .75 was used. The number of variables in the analysis was five and the type of statistical analysis was an ANOVA. Based on this information, 50 participants in each comparison group were required for this study.

2.2 Participants

This study recruited participants from throughout NZ, seeking a minimum of 50 participants overall. Eligibility of those expressing interest in participating in this study was assessed using the following inclusion criteria:

1. Over the age of 18
2. Have hearing impairment of any degree and aetiology
3. Ability to use spoken English for communication
4. Ability to complete the information sheet and two self-assessment questionnaires, either individually or with assistance
5. Ability to attend a hearing test consisting of pure-tone audiometry and the QuickSIN, and/or are able to send in a recent audiogram
6. Ability to return questionnaires either via post in a postage-paid envelope, or via electronic mail.

This study focused on adults with hearing impairment. The first criterion ensured participants were adults, and the second criterion attempted to ensure participants had HI. The third criterion ensured participants were able to book their hearing appointment over the phone, as well as understand the language of the information sheet and questionnaires (criterion four). The fourth, fifth, and sixth criteria were necessary to ensure complete data sets were collected from each participant.

Interested parties were excluded from this study if they did not meet the above requirements. Participants were remunerated for their travel expenses to and from their local hearing clinic with a \$20 voucher. However, some participants did not have a use for the petrol voucher, and so preferred a \$20 supermarket voucher. Participants indicated preference for either a petrol or supermarket voucher valued at \$20 when they returned the hearing test results, consent forms, and surveys.

2.3 Recruitment

The goal of recruitment for this study was to reach as many people as possible across the country. An active recruitment campaign began on 6th March 2013, running until 17th May 2013. During this time, a variety of media were used to disseminate information about the study, and the call for adults with hearing impairment to participate in it. Requests were made to various print, radio, and television media for any assistance they could provide, be it conducting interviews, relaying pānui, or including a poster in their publication.

Electronically, various email list moderators and website administrators were contacted with the request to disseminate the information to their membership or viewership. Hard copy posters and pamphlets were also disseminated both locally and in several national locations. Furthermore, recruitment took place in media and locations specifically targeted to members of the LGBTIQ community in an attempt to include members of this group in this research.

Members of the LGBTIQ community are generally underrepresented in the literature (Kelly-Campbell & Atcherson, 2012), perhaps reflecting a lack of professional interest in exploring this group (Leblanc & Tully, 2001).

2.3.1 Newsprint media

Recruitment began with contacting newsprint journalists. Although it was important for this study to have participants nationally and in both rural and urban centres, from a journalistic perspective this was a local (to Christchurch) piece. After reaching a local newspaper's health reporters via several different contacts, the thesis supervisor was interviewed and a small piece on the inside of the front page was published on 30th April, 2013 with some information about the study and a call for participants.

2.3.2 Television media

Emails were sent to the community announcement contacts of various local and national television stations in mid-March. Emails included a brief explanation of the study and the need for participants, the offer of an interview with the thesis supervisor, and a request for contact. No responses were obtained.

2.3.3 Radio media

Emails were sent to various local and national radio stations with information about the study, and the requests for an interview with Dr. Rebecca Kelly-Campbell and/or to include a call for participants. One radio station in New Plymouth responded with interest, and arrangements were made to put out a pānui in April of 2013.

2.3.4 Magazines, posters, and other print media

Contact was made either via telephone or email with the people responsible for community announcements at the various organisations. Posters, pamphlets, and flyers were

sent or posted both electronically and in hard copy to venues such as churches, community organisations, grocery stores, and libraries throughout New Zealand.

2.3.5 Electronic media

Dozens of email lists and electronic publications were approached either via email or telephone, and asked to support this study by forwarding the information about the study, and the call for participants, to their membership lists or on their websites. Almost all of the moderators responded, and subsequently forwarded the information to their lists.

2.3.6 Word of mouth

Participants were also recruited via word of mouth. The researchers ceased actively recruiting participants in early May. From this time forward, there was an increase in participants signing up to the study via word of mouth. Word of mouth recruitment took place via friends, family, co-workers, print newsletters, and social media.

Following an expression of interest via telephone or email, participants living outside Christchurch were given instructions for attending a hearing test in their region. This hearing test would be provided to all participants at no cost to them. A package was posted to each participant containing the questionnaires, information sheet, a voucher release form, and a stamped, addressed envelope to return these documents, along with the audiogram, upon completion. Participants residing in Christchurch were invited to attend their hearing test either at a private clinic, or at the Hearing Clinic at University of Canterbury. Participants completed a hearing test and returned their information sheet and questionnaires before receiving a petrol voucher. Participants were not paid for their involvement in this study.

2.4 Procedures

Participants were recruited from around NZ using the methods outlined previously. They were recruited from the general population, and attention was paid to recruiting participants that comprise a diverse group with respect to factors such as rural vs. urban location, and members of the LGBTIQ community.

People who contacted the researchers to indicate interest in participating in the study were asked to confirm that they met the eligibility criteria. If all eligibility criteria were met, the person was asked for their full name, contact information including mailing address, and their age. The information sheet about the study was mailed out to each participant, along with the information questionnaire, the Short Form 36 (Ware & Sherbourne, 1992), the HHIE (Ventry & Weinstein, 1982) (for those over 65 years of age), and the HHIA (Newman et al., 1991) (for those 18 - 65 years of age).

Participants were also asked if they had undergone an audiological assessment recently. For those participants who had not completed a hearing test in the previous 18 months, or who had completed one but whose HI was not stable in nature, an audiological evaluation was organised. These evaluations were conducted by an audiologist in the participant's community, and were provided at no cost to the participant. Participants situated in and around Christchurch were asked to either attend a hearing test at the Hearing Clinic at the University of Canterbury or at a private practice facility near to them.

Participants situated outside the Christchurch area were asked to attend a hearing test at a private practice audiology facility near to them. A single private practice provider with nation-wide facilities provided the hearing tests for these participants. These hearing tests were billed to the university and paid for using grant monies. For those participants who had

a recent hearing test completed and were able to obtain a copy of their results for the purposes of this study, testing was completed throughout NZ at various clinics, such as Hearing Technology, Hearing Excellence, Triton Hearing, Kapiti Hearing, Bay Audiology, and National Hearing Care.

For all participants not attending their hearing test at the university, a postage-paid addressed return envelope was sent to participants to enable return of all data and forms. Participants who received a hearing test at the university were asked to bring their completed paperwork with them when they attended their hearing test.

Self-assessment measurements were used to obtain perception of disease-specific and generic health-related QoL. Demographic information (age, relationship length, hours worked per week, income, ancestry, sex, level of education, city size, and sexual orientation) was also obtained. For participants in the Christchurch area who attended their hearing test at the University of Canterbury, documents were returned in-person. All other participants returned their documents via postage-paid envelope, or via electronic means. Once the complete data set was collected for each participant, they received a \$20 voucher. Aside from the voucher and the free hearing test, no other inducements were offered. These inducements are minimal and were designed to ensure that participants were not excluded from the study because they could not afford the cost of a hearing evaluation or travel to the clinic.

2.5 Measures

Two main audiometric and two main QoL variables were evaluated from each participant in this study. The instruments used to assess audiometric variables and quality of life are explained below.

2.5.1 Quality of life

Each participant was asked to fill out two different QoL instruments: one generic HRQoL measure, and one disease-specific HRQoL measure. The SF36 (Ware & Sherbourne, 1992) was completed by all 126 participants and provided the generic HRQoL measurement for this study. Each participant also completed a version of the HHI, which provided the disease-specific HRQoL measure for this study. As per the instructions for administering the HHI, participants under the age of 65 completed in the HHIA (Newman et al., 1991), which incorporates occupational and leisure questions, and participants over the age of 65 completed the HHIE (Ventry & Weinstein, 1982).

2.5.2 Audiometric variables

Two main audiometric variables were used in this study: hearing impairment, and speech understanding in noise. HI was divided into two variables, so a total of three audiometric variables were used. The methods used to measure each are described below.

2.5.2.1 Hearing impairment

The audiometric variable for HI was the pure-tone average (PTA) of air-conduction thresholds at four frequencies (.5, 1, 2, and 4 kHz). The PTA of the ear with the better hearing is referred to as the better ear PTA (BEPTA). The PTA of the ear with worse hearing is referred to as the worse ear PTA (WEPTA).

Hearing thresholds were assessed using pure-tone stimuli. For participants who received their hearing test at the University of Canterbury Speech and Hearing Clinic, stimuli were presented using a calibrated Grason-Stadler GSI-61 audiometer. EARTone 3A insert earphones, or TDH 50P supra-aural headphones delivered AC stimuli. For BC thresholds, stimuli were presented to the participant via a Radioear BC-71 bone vibrator, placed on the

mastoid bone. For all testing, stimuli were presented in sound-treated rooms at octave intervals from 250 Hz – 8 kHz for AC, and 500 Hz – 4 kHz for BC when necessary. BC testing was not conducted when AC thresholds were within normal limits between 500 and 4000 Hz. Thresholds were obtained according to the Modified Hughson-Westlake procedure in accordance with the University of Canterbury Hearing Clinic Protocols (UoC Speech and Hearing Clinic, 2011). Contralateral masking stimulus was presented when required using the criteria as follows: when the difference between AC thresholds in the ipsilateral and contralateral ears was greater-than, or equal-to, interaural attenuation values; when the difference between AC threshold in the ipsilateral ear and the presumed BC threshold in the contralateral ear was greater-than, or equal-to, interaural attenuation values; and finally, when the difference between the AC and BC thresholds in the ipsilateral ear showed an air-bone gap greater-than, or equal-to, 15 dB HL (UoC Speech and Hearing Clinic, 2011). Thresholds were obtained bilaterally for all participants.

2.5.2.2 Speech understanding in noise

The Quick Speech in Noise (QuickSIN) test was developed to quickly provide an estimate of an individual's signal-to-noise ratio loss (SNR loss) (Etymotic Research, 2001; Killion, Niquette, Gudmundsen, Revit, & Banerjee, 2004). The SNR loss represents the dB increase in signal-to-noise ratio needed by an individual to understand speech in noise compared with people who have normal hearing. Because SNR loss cannot be predicted reliably from pure tone data (Killion & Niquette, 2000), Killion and colleagues developed a quick method to estimate an individual's SNR loss. The QuickSIN test is a shortened, revised version of the Speech in Noise (SIN) test, which was originally developed to estimate the degree of difficulty understanding speech in noise that is representative of performance in daily life (Etymotic Research, 1993; Killion & Villchur, 1993). The SIN test provides a signal-to-noise ratio (SNR) for 50% correct for sentences containing five key words. These

sentences are organized into test blocks that were derived from the Institute of Electrical and Electronic Engineers (IEEE) sentences. The IEEE sentences were designed to contain few contextual cues to assist the listener in understanding (Killion et al., 2004).

According to Killion and colleagues (Etymotic Research, 2001), the QuickSIN test contains 12 equivalent lists containing six sentences with five key words. The administration time for each list was estimated to take about one minute. The Etymotic standardized recording of these sentences was used in this study. This recording presents the sentences, which were derived from the original SIN test, in a background of four-talker babble noise. The material was pre-recorded at signal-to-noise ratios decreasing in 5 dB steps from 25 to 0 dB. The presentation of the material in this study followed the instructions provided in the QuickSIN manual. That is, the material was presented binaurally following standardized instructions and practice sentences. For individuals whose PTA is less than or equal to 45 dB HL, the presentation level for the material was 70 dB HL. For individuals whose PTA is greater than 45 dB HL, the presentation level for the material was “loud, but OK” (Valente & VanVliet, 1997).

Also following the QuickSIN manual, the five key words in each sentence were scored and used to calculate SNR loss. One point was awarded for each key word the participant correctly repeated. The SNR loss was calculated using the following formula: $\text{SNR loss} = 25.5 - \text{Total Words Correct}$. Killion and colleagues stated that the formula used to calculate SNR loss was derived from the Tillman and Olsen method for obtaining spondee thresholds (Tillman & Olsen, 1973). When using a single QuickSIN list, Killion and colleagues (Etymotic Research, 2001) reported the 95% confidence interval is ± 2.7 dB. To increase accuracy and decrease the size of the confidence interval, multiple lists can be averaged to derive the SNR loss. The 95% confidence interval, as measured and reported by

Killion and colleagues (Etymotic Research, 2001), for two QuickSIN lists is ± 1.9 dB. For this study, two lists were measured and averaged to derived mean SNR loss for each participant. The two measured lists were presented after the participant was given two practice lists.

2.6 Statistical Analyses

Statistical analysis for this study was performed using the Statistical Package for the Social Sciences (SPSS version 20). Statistical significance was set at $p < 0.05$, and clinically significant effect size was set at $d = 0.75$.

Descriptive statistics were used to describe the sample in its entirety, and to describe the groups (hearing aids owners and non-owners, hearing assistance technology owners and non-owners). Pearson product-moment correlations were used to describe the relationship among the independent variables. Analyses of Variance and Chi square tests were used to assess statistically significant differences in demographic, audiometric, and quality of life variables based on hearing aid ownership and hearing assistance technology ownership. In addition, discriminant analyses were performed to determine the demographic, audiometric and/or quality of life variables that best discriminates hearing aid owners from non-owners and hearing assistance technology owners from non-owners.

2.7 Ethical Considerations

Following a review of the application to the University of Canterbury Human Ethics Committee (UC HEC), final ethics approval was granted from this body in February of 2013. The procedures carried out during the duration of this study remained in accordance with the UC HEC approval. This includes participant recruitment, inducement, consent, privacy, and

storage and future use of data. This study did not require approval from the NZ Health and Disability Ethics Committee.

Chapter Three: Results

3.1 Overview

This chapter presents the results of the data collected for this study. The sample characteristics are described, followed by results for the hypotheses. Overall, 126 participants participated in this study. The demographic makeup of this sample was representative of the NZ population, except in three areas: income, education, and NZ European ancestry were all higher amongst the sample than in the general population. Aside from income, which was positively correlated with the social scale of the HHI and the MCS and PCS, and age, which was positively correlated with MCS and negatively correlated with PCS scores, demographic factors tended not to have a significant impact upon generic and disease-specific HRQoL measures. Audiometric factors did have an impact on HHI scores. Furthermore, audiometric variables were found to have a relationship with both HA and HAT ownership.

3.2 Sample Characteristics

In total, 164 people responded to the calls for participants. Of those, 150 met eligibility criteria, based on self-report of HI. A total of 18 participants withdrew from the study. Two participants withdrew citing poor health, and three participants withdrew because they had difficulty scheduling an appointment and/or felt they were too busy to participate. One participant withdrew because they did not like the questions on the forms, and another participant withdrew after understanding that the research team did not dispense hearing aids. A further 9 participants were unreachable after three attempts after receiving their initial expression of interest. Finally, two participants did not attend their data collection sessions and did not respond to further contact attempts. After the data were collected, it was found

that six of the participants had hearing within normal limits, thus excluding them from the study.

In total, 126 data sets from eligible participants were collected. These people were sent an information sheet about the study (Appendix A). In total, data from 126 people were included in the final analysis of this study. Of these, 57 data sets included results from the QuickSIN. The QuickSIN is not commonly used in clinics in NZ and therefore those participants who sent recent audiograms did not typically have those scores included. Furthermore, technological limitations at some of the participating audiology clinics lead to the non-completion of the QuickSIN.

3.2.1 Demographic variables

The responses to questions in the personal information sheet (Appendix B) indicate that the demographic characteristics of the population sampled in this study were representative of the general population of Aotearoa/NZ, with the following exceptions: the income and education level of this sample was higher than the national averages, and the ancestry of this population reflected an under-representation of Māori and an over-representation of Pakeha or European. Table 2 shows the data for four of the independent demographic variables for the total sample.

Table 2. Age, relationship length, hours worked per week, and income for the total sample

Variable	N	Mean	SD	Minimum	Maximum
Age (years)	126	63.02	13.65	24	90
Relationship length (years)	126	22.92	18.4	0	61
Hours worked/week	126	12.85	16.53	0	50
Income* (NZD)	92	38,072.51	22,884.23	10,800	140,000

* Income variable includes data only for participants who reported an income > \$0.

The distribution of the age of participants is shown in figure 2.

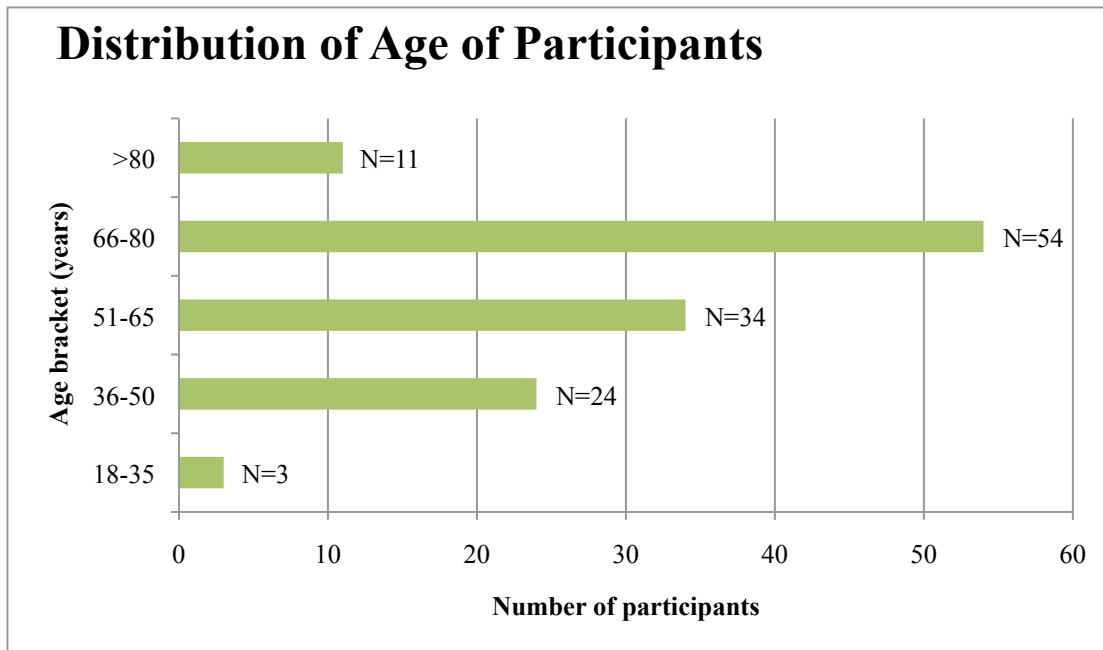


Figure 2. Distribution of age of participants ($N=126$).

The ancestry of participants as reported in the information sheet is displayed in Figure

3.

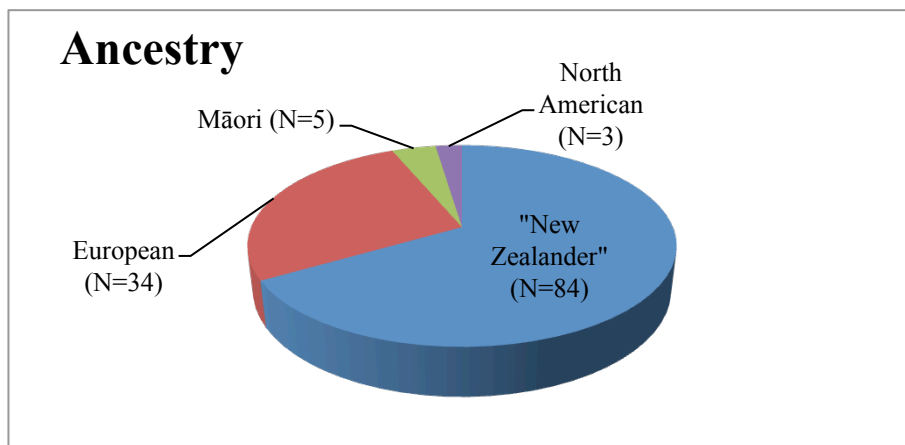


Figure 3. Ancestral identifiers for the total sample.

The sex of participants as reported in the information sheet is displayed in Figure 4.

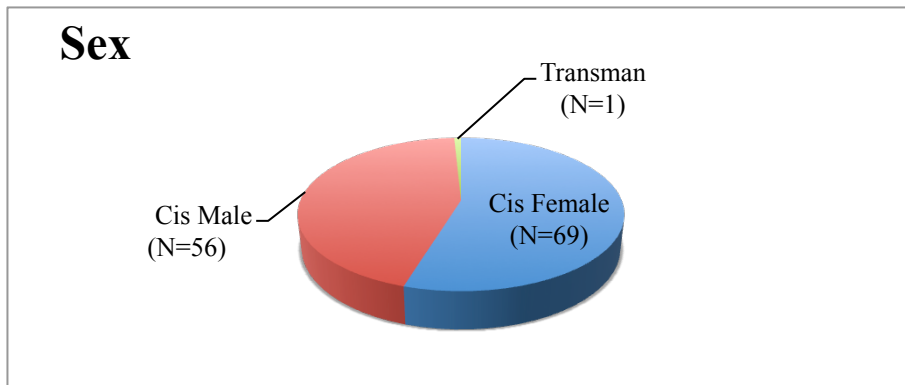


Figure 4. Reported sex characteristics for the total sample.

The education level of participants as reported in the information sheet is displayed in Figure 5.

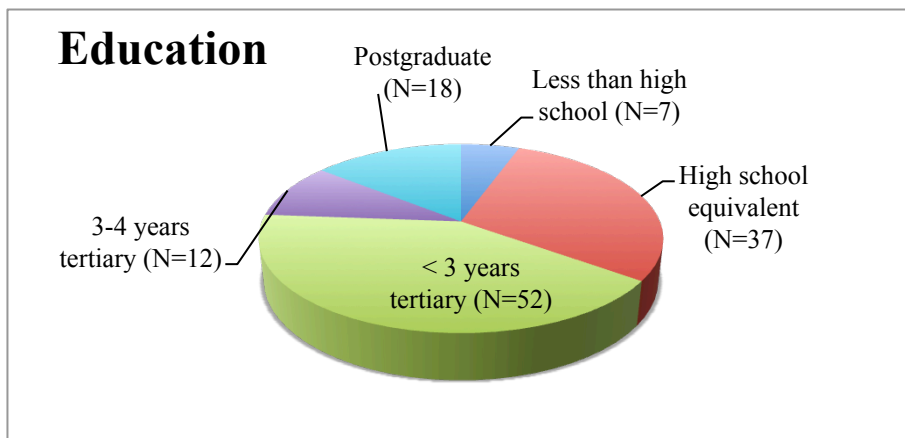


Figure 5. Reported education levels for total sample.

The location of residence for the total sample as reported in the information sheet is displayed in Figure 6.

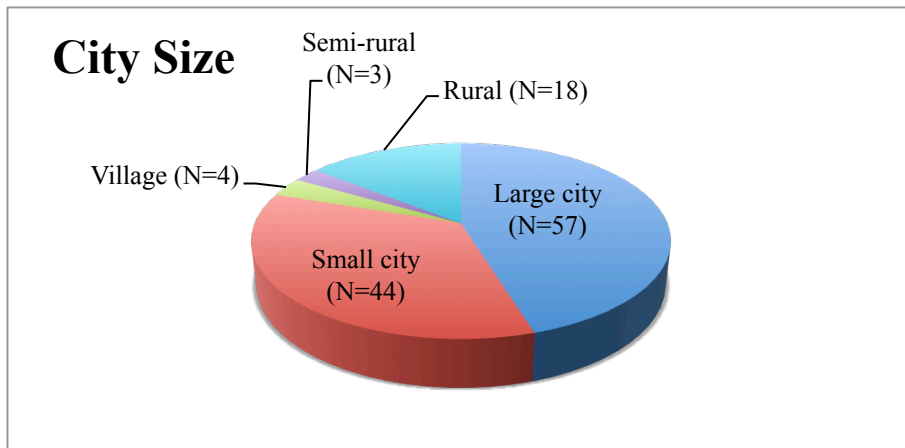


Figure 6. City size for total sample.

The sexual orientation for the total sample as reported in the information sheet is displayed in Figure 7.

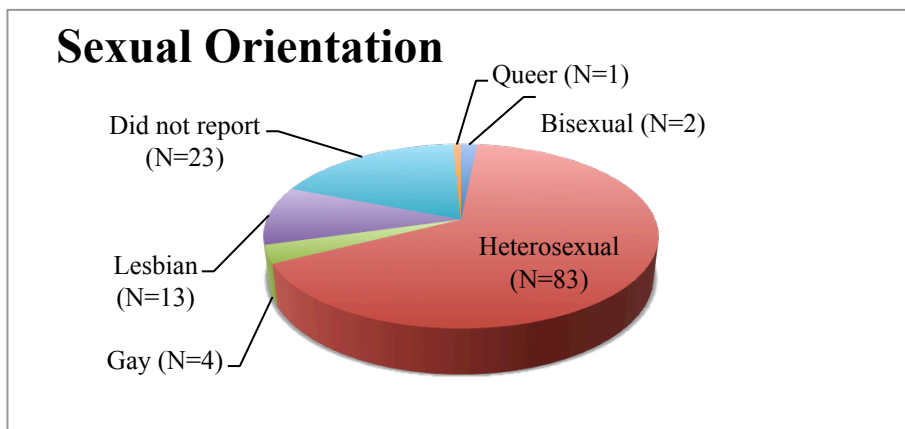


Figure 7. Sexual orientation for total sample. Includes non-reporters.

Hearing aid ownership amongst the participants, as reported in the information sheet, is displayed in Figure 8.

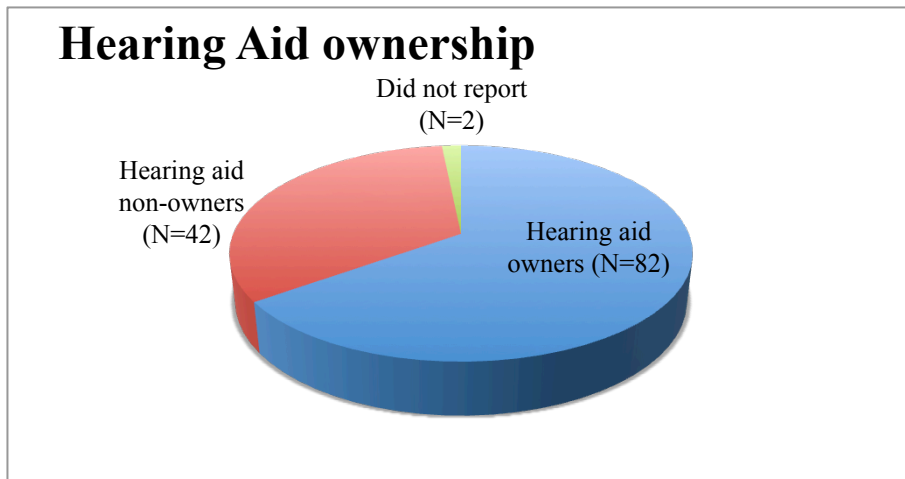


Figure 8. Hearing aid ownership for total sample.

Hearing assistance technology ownership amongst the participants, as reported in the information sheet, is displayed in Figure 9.

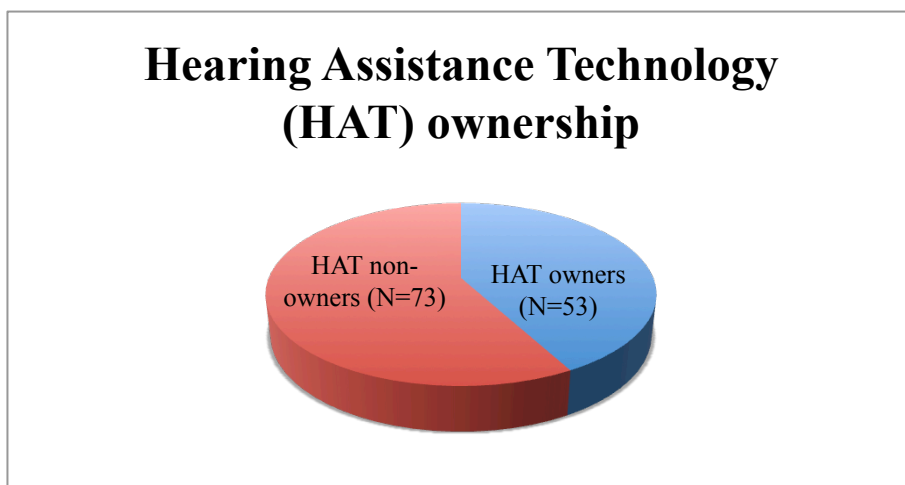


Figure 9. Hearing assistance technology ownership for total sample.

Type of HAT used is displayed in Figure 10.

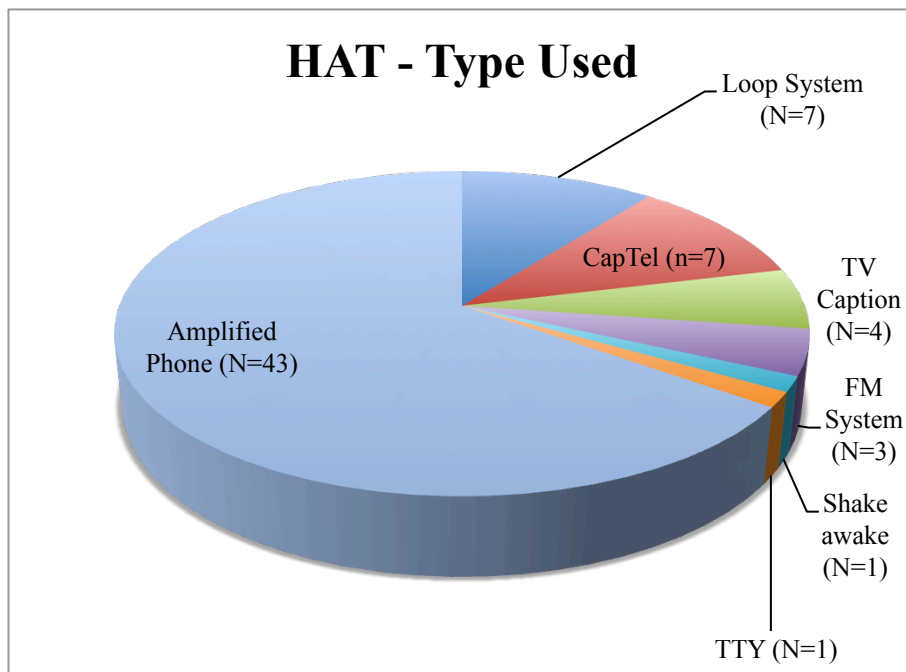


Figure 10. Type of HAT used by HAT owners. Note: some people owned more than one type of HAT.

Ownership of hearing aids and/or HAT for the total sample as reported in the information sheet is displayed in Figure 11.

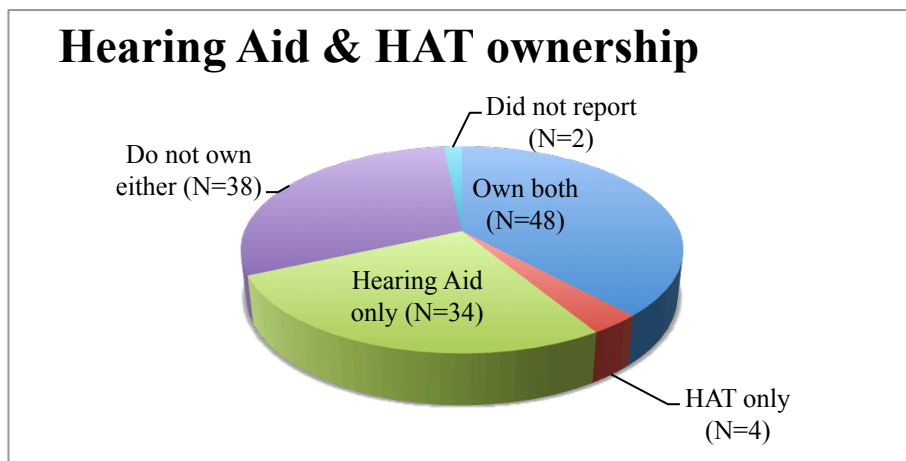


Figure 11. Hearing aid and HAT ownership for total sample. Includes non-reporters.

Two participants reported using cochlear implants.

3.2.2 Audiologic variables

There was a wide range of values for the audiologic variables. All variables ranged from within normal limits for some frequencies tested, to significant impairment. Table 3 shows the BEPTA, WEPTA, and SNR loss data for the total sample.

Table 3. Continuous audiologic variables for participants with measurable thresholds at all PTA frequencies ($N=118$).

Variable	N	Mean	SD	Minimum	Maximum
BEPTA	118	41.04	24.95	0	105
WEPTA	118	56.7	24.31	13.75	116.25
SNR loss	57	7.17	6.48	-3	25.5

Notes. **PTA** = puretone average, average air conduction thresholds at 500, 1000, 2000, and

4000 Hz. **BEPTA** = PTA of the better hearing ear; **WEPTA** = PTA of the worse hearing ear.

Only includes data for participants whose thresholds were measurable at all PTA frequencies.

SNR Loss = signal-to-noise ratio loss as measured by the Quick Speech in Noise Test.

3.2.3 Quality of life

There was also a wide range of values for the quality of life variables. MCS and PCS means were less than one point apart. For the HHI, there were similar scores for the emotional and social scales.

Table 4. HRQoL for entire sample.

Variable	N	Min	Max	Mean	SD
MCS	126	13.57	100	71.12	19.67
PCS	126	14.55	97.73	72.65	19.67
HHI Emotional	126	0	52	27.37	12.76
HHI Social	126	0	48	26.63	11.22

Notes. **MCS** = Mental Components Scale (SF-36). **PCS** = Physical Components Scale (SF-36). **HHI** = Hearing Handicap Inventory.

3.3 Hypothesis 1

There are two main hypotheses in this study. The first hypothesis focuses on the relationship between both demographic and audiometric factors, and generic HRQoL. The nine demographic variables are listed below under hypothesis 1(a), and the four audiometric variables are listed under hypothesis 1(b). There were no significant outliers in the results for either hypotheses.

3.3.1 Hypothesis 1(a)

Hypothesis 1(a) states: The perception of generic Health-Related Quality of Life for adults with hearing impairment is related to the following demographic variables: (a) age, (b) relationship length, (c) hours worked per week, (d) income, (e) ancestry, (f) sex, (g) education, (h) city size, and (i) sexual orientation. This hypothesis received only limited support, as only age and income were significantly related to generic HRQoL. Table 5 shows the Pearson product-moment correlations between generic HRQoL measures and the continuous demographic variables, specifically age, relationship length, hours worked per week, and income. Tables 6 – 10 show the results of the ANOVA tests for the categorical demographic variables, specifically ancestry (Table 6), sex (Table 7), education (Table 8), city size (Table 9) and sexual orientation (Table 10).

The generic HRQoL measures were related to some of the demographic variables. Scores on the SF-36 physical scale were related to age (as age increased, scores on the physical scales decreased), as were scores on the SF-36 mental scale (as age increased, so did functioning in the mental domain). Both the MCS and PCS were affected by income (as income increased, so did functioning in both domains). Scores on the SF36 were not affected by the remaining demographic variables: sex, level of education, sexual orientation, city size, and ancestry.

Table 5. Pearson correlations between generic HRQoL measures and continuous demographic measures.

	Age	Relationship length	Hours worked/week	Income
MCS	.176*	.156	.089	.337*
PCS	-.299*	-.009	-.190	.373*

* p < .05

Table 6. ANOVA for categorical demographic variables for generic HRQoL and ancestry.

		Sum of Squares	df	Mean Square	F	Sig.	η^2
MCS	Between Groups	3480.338	5	696.068	1.861	.106	.071
	Within Groups	44889.241	120	374.077			
	Total	48369.580	125				
PCS	Between Groups	2984.859	5	596.972	1.578	.171	.061
	Within Groups	45384.953	120	378.208			
	Total	48369.812	125				

Table 7. ANOVA for categorical demographic variables for generic HRQoL and sex.

		Sum of Squares	df	Mean Square	F	Sig.	η^2
MCS	Between Groups	101.985	1	101.985	.262	.610	<.01
	Within Groups	48267.595	124	389.255			
	Total	48369.580	125				
PCS	Between Groups	1231.949	1	1231.949	3.241	.074	.02
	Within Groups	47137.863	124	380.144			
	Total	48369.812	125				

Table 8. ANOVA for categorical demographic variables for generic HRQoL and education.

		Sum of Squares	df	Mean Square	F	Sig.	η^2
MCS	Between Groups	1809.698	4	452.425	1.176	.325	.03
	Within Groups	46559.881	121	384.792			
	Total	48369.580	125				
PCS	Between Groups	5340.552	4	1335.138	3.754	.006	.11
	Within Groups	43029.259	121	355.614			
	Total	48369.812	125				

Table 9. ANOVA for categorical demographic variables for generic HRQoL and city size.

		Sum of Squares	df	Mean Square	F	Sig.	η^2
MCS	Between Groups	1187.581	4	296.895	.761	.552	.02
	Within Groups	47181.999	121	389.934			
	Total	48369.580	125				
PCS	Between Groups	1875.892	4	468.973	1.220	.306	.03
	Within Groups	46493.920	121	384.247			
	Total	48369.812	125				

Table 10. ANOVA for categorical demographic variables for generic HRQoL and sexual orientation.

		Sum of Squares	df	Mean Square	F	Sig.	η^2
MCS	Between Groups	319.868	2	159.934	.409	.665	<.01
	Within Groups	48049.712	123	390.648			
	Total	48369.580	125				
PCS	Between Groups	1270.631	2	635.316	1.659	.195	.02
	Within Groups	47099.181	123	382.920			
	Total	48369.812	125				

3.3.2 Hypothesis 1(b)

Hypothesis 1(b) states: The perception of generic Health-Related Quality of Life for adults with hearing impairment is related to the following audiologic variables: (a) hearing aid ownership, (b) hearing assistance technology ownership, (c) better-ear pure-tone average, (d) worse-ear pure-tone average, and (e) the ability to understand speech in noise. This hypothesis received only limited support, as only HAT ownership and SNR loss were significantly related to generic HRQoL. Table 11 and 12 show the results of the ANOVA tests for the categorical audiometric variables, specifically hearing aid and hearing assistance technology ownership. Table 13 shows the Pearson product-moment correlations between generic HRQoL measures and continuous audiometric measures, specifically severity of hearing impairment (BEPTA and WEPTA), and the ability to understand speech in noise (SNR loss).

Table 11. ANOVA comparing generic HRQoL variables for HA owners and non-owners.

	F	df	p	d
MCS	.267	1,122	.606	.098
PCS	.047	1,122	.829	.041

HAT owners exhibited better functioning on the PCS than non-owners. Although there was a statistically significant differences, the effect size was relatively small (Table 12).

Table 12. ANOVA comparing generic HRQoL variables for HAT owners and non-owners.

	F	df	p	d
MCS	.626	1,125	.430	.141
PCS	4.07	1,125	.046*	.361

* $p < .05$

The generic HRQoL measures were also related to one of the audiometric variables. There was a moderate negative correlation between SNR loss and PCS (as the ability to understand speech in noise increased, physical functioning decreased). The scores on the MCS of the SF-36 and all remaining audiometric variables were small and insignificant. Similarly, the correlations between the PTA variables and the PCS were small and insignificant. There were no significant differences between participants who owned hearing aids and those who did not on either the PCS or MCS of the SF-36.

Table 13. Pearson correlations between generic HRQoL measures and continuous audiometric measures.

	BEPTA	WEPTA	SNR Loss
MCS	-.082	-.102	-.161
PCS	-.080	-.086	-.317*

* $p < .05$

3.4 Hypothesis 2

The second main hypothesis in this study focuses upon the relationship between disease-specific HRQoL and both demographic and audiometric factors. As above, the nine demographic factors are listed under hypothesis 2(a), and the four audiometric variables are listed under hypothesis 2(b).

3.4.1 Hypothesis 2(a)

Hypothesis 2(a) states: The perception of disease-specific Health-Related Quality of Life for adults with hearing impairment is related to the following demographic variables: (a) age, (b) relationship length, (c) hours worked per week, (d) income, (e) ancestry, (f) sex, (g) education, (h) city size, and (i) sexual orientation. This hypothesis was partially supported, with only income being significantly related to disease-specific HRQoL. Table 14 shows the Pearson product-moment correlations between disease-specific HRQoL measures and the continuous demographic variables. Tables 15 – 19 show the results of the ANOVA tests for the categorical demographic variables, specifically ancestry (Table 15), sex (Table 16), education (Table 17), city size (Table 18), and sexual orientation (Table 19).

The disease-specific HRQoL measures were related to some of the demographic variables. The HHI social subscale was significantly correlated with income in that as income increased, hearing handicap associated with the social scale decreased. The HHI emotional sub-scale was not significantly related to any demographic variable. Scores on the HHIE were not affected by the remaining demographic variables: sex, level of education, sexual orientation, city size, or ancestry.

Table 14. Pearson correlations between disease-specific HRQoL measures and continuous demographic variables.

	Age	Income	Relationship length	Hours worked/week
HHI Emotional	.019	-.170	-.032	-.034
HHI Social	.072	-.314*	-.028	-.153

* p <.05

Table 15. ANOVA for categorical demographic variables for disease-specific HRQoL and ancestry.

		Sum of Squares	df	Mean Square	F	Sig.	η^2
Emot	Between Groups	305.984	5	61.197	.366	.871	.01
	Within Groups	20049.484	120	167.079			
	Total	20355.468	125				
Soc	Between Groups	96.983	5	19.397	.149	.980	<.01
	Within Groups	15644.224	120	130.369			
	Total	15741.206	125				

Table 16. ANOVA for categorical demographic variables for disease-specific HRQoL and sex.

		Sum of Squares	df	Mean Square	F	Sig.	η^2
Emot	Between Groups	50.590	1	50.590	.309	.579	<.01
	Within Groups	20304.879	124	163.749			
	Total	20355.468	125				
Soc	Between Groups	.154	1	.154	.001	.972	<.01
	Within Groups	15741.053	124	126.944			
	Total	15741.206	125				

Table 17. ANOVA for categorical demographic variables for disease-specific HRQoL and education.

		Sum of Squares	df	Mean Square	F	Sig.	η^2
Emot	Between Groups	688.772	4	172.193	1.059	.380	.03
	Within Groups	19666.696	121	162.535			
	Total	20355.468	125				
Soc	Between Groups	465.306	4	116.327	.921	.454	.02
	Within Groups	15275.900	121	126.247			
	Total	15741.206	125				

Table 18. ANOVA for categorical demographic variables for generic HRQoL and city size.

		Sum of Squares	df	Mean Square	F	Sig.	η^2
Emot	Between Groups	406.155	4	101.539	.616	.652	.02
	Within Groups	19949.313	121	164.870			
	Total	20355.468	125				
Soc	Between Groups	348.113	4	87.028	.684	.604	.02
	Within Groups	15393.094	121	127.216			
	Total	15741.206	125				

Table 19. ANOVA for categorical demographic variables for generic HRQoL and sexual orientation.

		Sum of Squares	df	Mean Square	F	Sig.	η^2
Emot	Between Groups	468.972	2	234.486	1.450	.238	.02
	Within Groups	19886.497	123	161.679			
	Total	20355.468	125				
Soc	Between Groups	333.281	2	166.641	1.330	.268	.02
	Within Groups	15407.925	123	125.268			
	Total	15741.206	125				

3.4.2 Hypothesis 2(b)

Hypothesis 2(b) states: The perception of disease-specific Health-Related Quality of Life for adults with hearing impairment is related to the following audiologic variables: (a) hearing aid ownership, (b) hearing assistance technology ownership, (c) better-ear pure-tone average, (d) worse-ear pure-tone average, and (e) the ability to understand speech in noise. This hypothesis was partially supported, with HA ownership, BEPTA, WEPTA, and SNR loss being significantly related to disease-specific HRQoL. The results of the ANOVA tests for the categorical audiometric variables, specifically hearing aid and hearing assistance technology ownership, are displayed in Tables 20 and 21. Table 22 shows the Pearson product moment correlations between disease-specific HRQoL measures and continuous audiometric measures, specifically severity of hearing impairment (BEPTA and WEPTA), and the ability to understand speech in noise (SNR loss).

Table 20. ANOVA comparing disease-specific HRQoL between HA owners and non-owners.

	F	df	p	d
HHI Emotional	19.69	1,122	<.001	.824
HHI Social	41.40	1,122	<.001	1.21

Table 21. ANOVA comparing disease-specific HRQoL variables between HAT owners and non-owners.

	F	df	p	d
HHI Emotional	3.24	1,125	.074	.327
HHI Social	14.13	1,125	<.001	.674

The disease-specific HRQoL measures were also related to audiometric variables. Specifically, the HHI Emotional and Social subscales were significantly positively correlated with BEPTA, WEPTA, and SNR loss. That is, as hearing impairment increased and speech understanding in noise decreased, hearing handicap increased.

Table 22. Pearson correlations between disease-specific HRQoL measures and continuous audiometric variables.

	BEPTA	WEPTA	SNR Loss
HHI Emotional	.398*	.422*	.369*
HHI Social	.583*	.534*	.534*

* p <.05

3.5 Hypotheses Summary

In summary, these results have shown generic HRQoL scores had a significant relationship with the following variables: age, income, SNR loss, and HAT ownership. The variables that have a significant relationship with disease-specific HRQoL were income, HA and HAT ownership, BEPTA, WEPTA, and SNR loss.

3.6 Discriminant analysis

The previous analyses found that hearing aid owners reported statistically

significantly higher handicap on disease-specific HRQoL. Specifically, hearing aid owners reported greater handicap on both the emotional and social subscales of the HHI.

Furthermore, results from audiometric testing revealed statistically significantly worse audiometric measures when compared with non-owners. Specifically, these audiometric measures were BEPTA, WEPTA, and SNR loss.

It was also found, in the previous analyses, that HAT owners reported statistically significantly greater handicap on the HHI. Specifically, the handicap reported in the emotional subdomain was statistically significantly higher amongst this group than amongst HAT non-owners. HAT owners also reported worse scores on the PCS of the SF-36 than non-owners. Results from audiometric testing revealed statistically significantly worse audiometric measures (BEPTA, WEPTA, and SNR loss) than amongst non-owners. Furthermore, HAT owners reported statistically significantly less income and education than non-owners. Significantly more HAT owners also tended to be male than female.

Discriminant analyses were performed to determine the relative significance of the audiometric and demographic variables in categorising (a) hearing aid owners and non-owners and (b) between HAT owners and non-owners. Four questions were generated for this purpose, and applied to each of the two main technologies (HA and HAT). Those questions are as follows:

(a) Which demographic variables discriminate owners and non-owners?

(b) Which audiometric variables discriminate owners and non-owners?

(c) Which quality of life variables discriminate owners and non-owners?

(d) Based on the results of a-c, which of the significant variables discriminate owners and non-owners?

The discriminant analyses for HA (Table 23) and HAT (Table 24) ownership are below.

Table 23. Discriminant analysis for hearing aid ownership.

	Question (a) Demographic variables	Question (b) Audiometric variables	Question (c) QoL variables	Question (d) Significant variables
Total participants	N = 91	N = 56	N = 124	N = 56
Hearing aid owners	N = 58	N = 29	N = 82	N = 29
Hearing aid non-owners	N = 33	N = 27	N = 42	N = 27
Significant variables (in order of importance in analysis)	None	WEPTA, BEPTA, SNR loss	HHI Social, HHI Emotional	HHI Social, WEPTA, SNR loss, BEPTA, HHI Emotional
Homogeneity of variance	Not violated	Violated	Violated	Violated
Function significant?	No	Yes	Yes	Yes
Loadings	N/A	All variables have loadings >.30	Emotional and Social have loadings >.30	All variables have loadings >.30
Discriminant function	N/A	$D_i = -2.904 + .054 \text{ WEPTA} + .012 \text{ BEPTA} - .013 \text{ SNRloss}$	$D_i = -5.142 + .126 \text{ Social} - .011 \text{ Emotional} + .024 \text{ MCS} + .005 \text{ PCS}$	$D_i = -3.645 + .083 \text{ Social} + .031 \text{ WEPTA} - .039 \text{ SNR loss} + .006 \text{ BEPTA} + .008 \text{ Emotional}$
Cut point	N/A	Mid-way between the centroids	Sample sizes are very dissimilar	Sample sizes are similar
% cases classified correctly by discriminant function	59.3%	80%	76.6%	89.3%
Separation vs. overlap between groups on graph?	Great deal of overlap between groups	Some overlap, but fairly good separation in majority of cases	Some overlap, but fairly good separation in majority of cases	Some overlap, but fairly good separation in majority of cases

Demographic variables did not discriminate the two groups. Audiometric and quality of life variables differentiated the hearing aid owners from the non-owners. The variables that

were important in the discriminant function were (in descending order): HHI Social, worse ear PTA, SNR loss, better ear PTA, HHI Emotional. The function appears to be efficient in that it correctly classified nearly 90% of the hearing aid owners and non-owners in this sample ($N=56$).

Table 24. Discriminant analysis for HAT ownership.

	Question (a) Demographic variables	Question (b) Audiometric variables	Question (c) QoL variables	Question (d) Significant variables
Total participants	N = 92	N = 56	N = 124	N = 41
Hearing aid owners	N = 37	N = 20	N = 82	N = 15
Hearing aid non-owners	N = 55	N = 36	N = 42	N = 26
Significant variables (in order of importance in analysis)	Age, Income	All	PCS, Social are significant; MCS, Emotional are not	Emotional, Social, SNR, BEPTA, WEPTA
Homogeneity of variance	Violated	Violated	Not Violated	Violated
Function significant? Loadings	Yes Income, age, relationship length	Yes BEPTA, SNR loss, WEPTA	Yes Social, Emotional, PCS, MCS	Yes BEPTA, WEPTA, Social, Emotional, SNR Loss
Discriminant function	Income, age have loadings >.30	All variables have loadings >.30	Emotional, Social, PCS have loadings >.30	All significant variables have loadings >.30
Cut point	$D_i = .909 + .029\text{Age} + .003\text{Rel length}$	$D_i = -2.169 + .033\text{BEPTA} + .014\text{WEPTA} + .046\text{SNRloss}$	$D_i = -1.049 + .013\text{MCS} - .023\text{PCS} - .027\text{Emotional} + .143\text{Social}$	$D_i = -2.122 + .023\text{BEPTA} + .018\text{WEPTA} + .029\text{Social} + .006\text{Emotional} - .001\text{SNR loss}$
% cases classified correctly by discriminant function	N/A	Mid-way between the centroids	Sample sizes are dissimilar	N/A
Separation vs. overlap between groups on graph?	68.5%	83.9%	70.6%	78.0%
Total participants	Great deal of overlap	Great deal of overlap	Some overlap between groups	Some overlap between groups
Significance found in non-continuous variables?	None	N/A	N/A	N/A

Overall, audiometric and HRQoL variables differentiated the HAT owners from the non-owners. The variables that were important in the discriminant function were (in

descending order): BEPTA, WEPTA, HHI Social, HHI Emotional, SNRloss. The function appears to be efficient in that it correctly classified nearly 78% of the HAT owners and non-owners in this sample ($N=41$).

These results show a similar pattern to the analysis for hearing aid ownership. In both analyses, the audiometric and HRQoL variables best distinguish ownership from non-ownership. However, the order of importance is different for the two analyses. For the hearing aid ownership analysis, HRQoL and WEPTA seemed to be the best predictors. For the HAT analysis, BEPTA and WEPTA (i.e., degree of hearing impairment) seemed to be the best predictors. These variables are better at discriminating hearing aid owners from non-owners than they are at discriminating HAT owners from non-owners.

3.6.1 Outliers

Extreme outliers were removed and all analyses were run again. This did not change the results of the analyses.

3.6.2 Discriminant analysis summary

In summary, the results of the discriminant analysis have shown that no demographic variables discriminated hearing aid owners from non-owners, but all audiometric measures (BEPTA, WEPTA, and SNR loss) did discriminate these groups. In terms of HRQoL predictors of HA ownership, generic measures did not differentiate the groups, whereas the disease-specific HRQoL scores did. Overall, the most predictive factors of HA ownership, in descending order, were the HHI Social/Situational scale, WEPTA, SNR loss, BEPTA, and the HHI Emotional scale.

For HAT ownership, the demographic variables of age and income discriminated owners from non-owners, as did all audiometric variables (BEPTA, WEPTA, and SNR loss).

Generic HRQoL predictors of HAT ownership were scores of the PCS scale. For disease-specific HRQoL, the Social/Situational scale differentiated HAT owners. Overall, the most predictive factors of HAT ownership in descending order, were: HHI Emotional, HHI Social/Situational, SNR, BEPTA, and WEPTA.

Chapter Four: Discussion

This chapter discusses the findings of the study. The aim of this study was to investigate the relationships between audiometric variables, demographic variables, generic and disease-specific HRQoL, and device (HA or HAT) ownership. Three audiometric variables were used: better-ear pure-tone average (BEPTA), worse-ear pure-tone average (WEPTA), and signal-to-noise ratio (SNR) loss. Demographic variables were collected via an information sheet and included age, relationship length, hours worked per week, income, ancestry, sex, education, city size, and sexual orientation. The information sheet also enquired about device ownership. The Short Form 36 Health Survey (Ware & Sherbourne, 1992) and the Hearing Handicap Inventory (Newman, Weinstein, Jacobson, & Hug, 1991; Ventry & Weinstein, 1982) were used to assess HRQoL. Pearson product-moment correlations were used to determine presence of relationships between the variables. Analyses of variance were used to determine differences between device owners and non-owners. Finally, discriminant analyses were used to assess predictive factors amongst those two groups.

4.1 Relationship Between Generic HRQoL and Demographic Variables

Hypothesis 1(a) stated that perception of generic HRQoL for adults with HI would be related to demographic variables, specifically (a) age, (b) relationship length, (c) hours worked per week, (d) income, (e) ancestry, (f) sex, (g) education, (h) city size, and (i) sexual orientation. This study found that age and income were correlated with perception of generic HRQoL as measured by the SF-36, thus supporting the hypotheses for those two demographic variables. Ancestry, sex, level of education, and sexual orientation were not

correlated with any subscale of the SF-36, thus not supporting the hypotheses for those variables. Overall, this study's findings for hypothesis one were supported by data from the NZ public as collected by the Ministry of Health in the 1996/1997 New Zealand health survey (Ministry of Health – Manatū Hauora, 1999).

The relationship between SF-36 scores and demographic variables for the participants in this study reflected the SF-36 scores for the general NZ public. The population of this study was comprised entirely of adults with some degree of HI, while the NZ health survey was a random sampling of the entire population, regardless of presence of HI. The SF-36 does not contain any questions or domains directly related to communication or hearing. The observation made by Chisolm and colleagues (2005) that generic HRQoL measures may be sensitive to presence of HI only if the instrument contains these types of questions, therefore suggests that SF-36 scores amongst those with HI would be similarly related to demographic variables as found amongst the general public.

4.1.1 Age

In this study, as age increased, scores on the physical functioning scale decreased. The 1996/1997 New Zealand health survey, which collected SF-36 scores from over 7,300 people (3000 men, 4300 women) from the general population in New Zealand who were above the age of 15, showed a similar decrease in the PCS scores as age of respondents increased (Ministry of Health – Manatū Hauora, 1999). This trend is mirrored in Australia (Butterworth & Crosier, 2004) and in the United States of America (Ware, Kosinski, & Keller, 1994).

As age increased, scores on the mental functioning scale also increased, suggesting an increase in mental functioning amongst participants in this study. However, the clinical significance was minimal, only 3.1% of MCS variance was accounted for by age. In the New

Zealand health survey, this trend was also present up to the age of 75; a slight decrease on MCS scores was seen in those over aged 75. Similarly, an increase in MCS scores was seen alongside an increase in age excepting a slight decline in the uppermost age bracket in Australians (Butterworth & Crosier, 2004). A different Australian study, however, did not find any relationship between age and either the mental or physical SF-36 scores (Morgan et al., 2002). The discrepancies between these two studies could be attributed to the range of ages of participants, the sample sizes, and the populations used in each study. Butterworth & Crosier had a population of over 13,000 respondents, who ranged in age from 15 to 90 years old or greater. The characteristics of their respondents were not statistically significantly different to the estimates of the general Australian population from the Australian Bureau of Statistics (Butterworth & Crosier, 2004). In contrast, the latter study conducted in 2002 by Morgan and colleagues, consisted of less than 100 participants of whom the youngest was 59 years of age, therefore including only older adults. The participants were people who had already completed a previous study and thus may have different characteristics from the general Australian population. When a relationship is not found between age and generic HRQoL, the age range of participants must be taken into account, as it is less likely that a relationship between age and generic HRQoL would be present in a population with a smaller age range, than in a population with greater variation.

4.1.2 Income

As income increased, scores on both the MCS and PCS scales of the SF-36 also increased, indicating better mental and physical HRQoL as income increased. This was also a trend in the NZ health survey (Ministry of Health – Manatū Hauora, 1999), and was present regardless of sex or whether respondents were Māori, non-Māori, female, or male in both studies. Furthermore, in this study, as income increased, perception of Social handicap on the HHI decreased. In fact, the only measure that was not correlated with income in this study

was the Emotional scale of the HHI. While there was a large range of incomes reported for participants in this study, the average income remained higher than that of the general NZ population. Therefore, the impact of income as found in this group cannot be generalised to the entire population of NZ.

4.1.3 Non-significant demographic variables

The SF-36 scales were not significantly related to any of the remaining demographic variables (hours worked per week, ancestry, education, city size, and sexual orientation). Level of education also did not significantly impact the PCS and MCS scales for the NZ health survey. The remaining demographic variables present in this study were not taken into account in that survey.

4.2 Relationship Between Generic HRQoL and Audiologic Variables

Hypothesis 1(b) stated that the perception of generic Health-Related Quality of Life for adults with hearing impairment is related to audiologic variables, specifically (a) hearing aid ownership, (b) hearing assistance technology ownership, (c) better-ear pure-tone average, (d) worse-ear pure-tone average, and (e) the ability to understand speech in noise. This study found that the use of HATs and the ability to understand speech in noise were correlated with perception of generic HRQoL as measured by the SF-36, thus supporting the hypotheses for those two audiometric variables. The severity of HI and use of hearing aids were not correlated with any subscale of the SF-36, thus not supporting the hypotheses for those variables. There are mixed data in the literature reporting on the relationship between certain audiometric variables and generic HRQoL.

4.2.1 Hearing assistance technology ownership

Participants in this study who owned HATs reported statistically and clinically significantly higher scores on the PCS subscale of the SF-36, indicating better HRQoL for physical function for this group compared with those who did not own HATs. Thus the results from this study support this hypothesis. Furthermore, HAT owners were more likely to be male, and to have lower income and education levels. There are no data available to support or refute these relationships. The results from this study seem to suggest that HAT use is related to a more active lifestyle, and that in this sample, demographic variables might also be related to HAT ownership.

Recall that HATs are relatively inexpensive devices, often used to facilitate communication. In this study, participants tended to primarily report use of amplified telephones ($N=39$). In New Zealand, service delivery models for HATs are different than for HAs. For example, funding for amplified phones and other HATs can be accessed by Hearing Therapists, provided they are Accredited Assessors for HATs, on behalf of people with HI. Should full funding not be granted for the HAT, the amount required for the user to contribute would be substantially smaller than for HAs.

The discriminant analysis also showed that HAT owners tended to be male and report lower income than HAT non-owners. One possibility for these relationships is that Hearing Therapists work closely with the NZ Returned Services Association (RSA), who are often male. Further research is needed to explore HRQoL and demographic factors influencing decision-making for HAT adoption are needed both in NZ and overseas.

4.2.2 Understanding speech in noise

For participants in this study, the ability to understand speech in noise was associated with perception of generic HRQoL, thus supporting this hypothesis. Specifically, there was a moderate negative correlation between SNR loss and the PCS. As scores for SNR loss increased, indicating less ability to understand speech in noise, the physical component scale scores decreased. While there are no other data to shed more light on what causes this relationship, it is possible that this relationship is being influenced by other factors. For example, we know that HI can have negative psychosocial consequences (Mulrow et al., 1990), so perhaps there is also a relationship between SNR loss and psychosocial impacts, which could then impact upon an individual's physical maintenance and, over time, performance. However it is important to note none of these conclusions can be inferred from the results in this study, and further research in this area is needed to replicate the relationship between SNR loss and PCS scores.

4.2.3 Non-significant variables

4.2.3.1 Hearing aid ownership

The use of hearing aids did not show a significant relationship to either the MCS or PCS of the SF-36 in this study, thus this hypothesis was not supported. There are mixed data in the literature regarding the relationship between use of hearing aids and generic HRQoL measures, especially when only considering studies that have used the SF-36 as their generic measure. As discussed in Chapter One, the questions and subscales of the SF-36 are not focused upon communicative aspects of HRQoL (Abrams, Chisolm, & McArdle, 2005) and therefore may not be sensitive to intervention via use of hearing aids (Bess, 2000). For example, Crandell (1998) found no statistically significant shift on SF-36 scales amongst participants who received intervention in the form of hearing aids between the pre-fitting, 3 month, and 6 month follow-up measures.

However, other studies have found that introduction of hearing aids did significantly increase SF-36 scores. For example, one study in the USA found a statistically significant change to the MCS following use of hearing aids (Abrams, Chisolm, & McArdle, 2002), and an Australian study found a statistically significant change to the PCS following use of hearing aids (Chia et al., 2007).

Two other studies found shifts in particular subscales of the SF-36 (Joore et al., 2003; Stark & Hickson, 2004). Joore and colleagues (2003) determined that there was an increase in social functioning following hearing aid fitting in 80 adults with HI. That study used the EQ-5D to measure the generic HRQoL, but the researchers also included the two items of the social functioning domain of the SF-36. Therefore it is unclear if there would have been any statistically significant changes to other subscales on the SF-36 in this sample, which was drawn from a clinical population who had attended an ENT or audiology clinic, and had been prescribed hearing aids prior to taking part in that study.

Stark & Hickson (2004) used the SF-36 to measure general health for a group of participants before and after fitting and wearing hearing aids. They found participants reported worse general health after being fit with hearing aids. The participants in that study were from a clinical population; that is, the 131 participants were recruited after having elected to attend a hearing assessment at an audiology clinic. It is possible that this particular group of people were more actively engaged with managing their general health status than non-clinical populations in other studies. The authors also suggest two possible reasons for the outcome; firstly, that the contrast between aided and unaided hearing had illuminated the extent to which HI was present, thus reducing participants' general perception of HRQoL; secondly, that the social perception that hearing aids are correlated with frailty and old age may have caused the participants to perceive their health as deteriorating.

Aside from the SF-36, other generic HRQoL instruments have been shown to be more sensitive to hearing aid intervention. Although Crandell (1998) did not find significant improvement of generic HRQoL scores using the SF-36 following provision of hearing aids, the same study did report statistically significantly lower SIP scores for this sample at both the 3 month and 6 month follow-ups. Recall that the SIP is another generic HRQoL instrument focusing on physical and psychosocial function. It also includes questions specifically focused on communication, therefore its sensitivity to intervention would be expected. Bess and colleagues (1990) also found the SIP to be sensitive to use of hearing aids.

It is also important to note that, when taking into consideration other generic HRQoL measures aside from the SF-36, some studies have also found that there is no statistically significant relationship between the introduction, or use, of amplification and generic HRQoL (Mulrow et al., 1990; Mulrow, Tuley, & Aguilar, 1992). These studies used the Self Evaluation of Life (SELF) instrument, the scores on which did not statistically significant change pre- and post-fitting in the intervention group. The population of these two studies were recruited primarily from a veteran's hospital, which is not representative of the general population of the USA. For example, over 99% of participants were male, and 97% were Caucasian. Despite being a clinical population insofar as they had visited the veteran's hospital at some point between June 1987 and June 1988, these participants had not necessarily actively sought audiological assessment prior to participating in these studies.

4.2.3.2 Severity of hearing impairment

No significant relationship was present between the severity of HI and either the MCS or PCS of the SF-36 in this study. Participants with mild hearing loss did not report

significantly different perception of generic HRQoL than participants who had profound hearing loss. Therefore, this hypothesis was not supported by the results of this study.

Previous studies have reported a relationship between severity of HI and perception of generic HRQoL as measured by the SF-36. An Australian population-based survey with over 2400 older participants conducted in 2007 (Chia et al., 2007) found that poorer SF-36 scores on both the MCS and PCS scales were associated with greater severity of HI. Similar findings were previously reported by Dalton (2003) in a population-based longitudinal study from the USA, where decreased MCS and PCS scores were associated with worse levels of HI amongst over 2600 older participants. Morgan, Hickson, and Worrall (2002), also found that amongst 93 older Australian participants, decreased scores on the mental health domain of the SF-36 were associated with HI.

It is unknown why this study did not find a relationship between severity of HI and scores on the SF-36, however there are several differences aside from location between this study and those by Chia and colleagues in Australia (2007), Dalton in the USA (2003), and Morgan and colleagues in Australia (2002). This sample study included only people with known HI, whereas the aforementioned population studies included participants who had no HI. Furthermore, the mean age of the present study, 63.02 years (13.65) was lower than in the aforementioned studies, and the range of ages was larger (24 – 90).

4.3 Relationship Between Disease-Specific HRQoL and Demographic Variables

Hypothesis 2(a) stated that the perception of disease-specific Health-Related Quality of Life for adults with hearing impairment is related to demographic variables, specifically (a) age, (b) relationship length, (c) hours worked per week, (d) income, (e) ancestry, (f) sex, (g) education, (h) city size, and (i) sexual orientation. This study found that amount of income

was negatively correlated with perception of disease-specific HRQoL as measured by the HHI, thus supporting the hypothesis for that variable. Specifically, as income increased, perception of social handicap decreased. Age, sex, level of education, sexual orientation, and cultural/ethnic identity were not associated with the social or emotional domains of the HHIE, thus not supporting the hypotheses for those variables.

4.3.1 Income

Income has been clearly shown to have a relationship with generic HRQoL in NZ (Ministry of Health – Manatū Hauora, 1999), but there are no local data for these variables amongst the HI population. In this study, the reported median income (\$29,120) was slightly higher than the national median income (\$24,000; Statistics New Zealand, 2006b). It is possible that the relationship between income and the Social/Situational scale of the HHI found in this study is a reflection of the generally better health status reported by people with higher incomes. It is unknown why only the Social/Situational subscale showed a significant relationship; further exploration in this area is required.

4.3.2 Non-significant findings

Scores on the HHI were not significantly related to any of the remaining demographic variables (age, relationship length, education, hours worked per week, city size, ancestry, or sexual orientation). Since there are some data available to be used for comparison, the non-significant variables of age, income, and sex are discussed further, below.

4.3.2.1 Age

No statistically significant relationship was found between age and either subscale of the HHIE or HHIA; perception of social or emotional handicap related to HI was not affected by age in this study. This finding is not supported by previous research. Gordon-Salant and

colleagues (1994) looked at the effects of age on perception of handicap as measured by the HHIA and HHIE, and showed that younger people (aged 18-40) reported higher handicap associated with mild-moderate HI, than those aged 65 and over. The authors suggest that this might reflect the greater communication needs for younger, working adults (Gordon-Salant, Lantz, & Fitzgibbons, 1994). There are some major differences between these two studies, which may have contributed to the discrepancies. The sample of each study had some particular differences. First, the age distribution of participants was dissimilar; there were equal numbers of older and younger participants in the study by Gordon-Salant and colleagues, whereas in this study, there were a higher number of older participants than younger. The second difference between the samples for these studies is that the sample in the present study was recruited from both the clinical population of HI adults, whereas participants in the other study were a clinical population of HI adults. Demographic factors aside from age were not mentioned in that study; in this study, it was found that one demographic factor, income, was significantly correlated with the social scale of the HHI. Therefore the results of both studies may be affected by factors such as this.

Based upon the study by Garstecki & Erler (1999), we might have expected the perception of disease-specific HRQoL to be affected by age. In that study, both men and women assigned the highest level of communication importance to be in work, or work-like, situations. One major difference between that study and this one is that participants in that study were all over age 65, therefore were less likely to be in work situations and more likely to be considering work-like situations when responding to the questions.

Because the average income amongst participants of this study was higher than the average income of the NZ population, it is possible that the relationship between age and disease-specific HRQoL measures would be affected. For example, income was correlated

with lower scores on the Social component of the HHI (indicating less handicap) for participants in this study. The benefit of higher income might outweigh the effect of age on disease-specific measures of HRQoL found in other studies.

4.3.2.2 Sex

This study did not find a relationship between sex and scores on the HHI. These findings are not supported by previous studies, particularly those by Erdman & Demorest (1998), and Garstecki & Erler 1999. Erdman & Demorest argue that far from biological factors being the sole determinant of the relationship between sex and other variables, sociological factors must be taken into account. Furthermore, the ICF framework suggests that health conditions exist not independently of environmental and personal factors. Therefore, further research is needed to explore the relationships between demographic factors and disease-specific HRQoL in NZ.

4.3.2.3 Income

This study did not find a relationship between income levels and hearing aid ownership. There are mixed data regarding the relationship between these variables. Researchers have sometimes found that adults with HI who did not own HAs reported higher incomes (Garstecki & Erler, 1998; Gussekloo et al., 2003) but others found those reporting higher incomes did tend to own hearing aids, though the relationship was not statistically significant (Fischer et al., 2011). The average income for the sample in the present study was higher than the average for the NZ population (Ministry of Health – Manatū Hauora, 1999), which may have influenced the findings herein. For example, had more participants reported lower incomes to the point that the average income for participants in this study matched the NZ national average, it is possible that a relationship would have been found with hearing aid ownership. However, the current service delivery model for HAs in NZ includes a

government subsidy of \$511.11 per ear for any person who needs hearing aids. It is possible to receive a pair of HAs for this price. Therefore, it is possible that HA ownership is less dependent on income level in NZ than in countries where there is little or no HA funding. More research is needed to explore these variables within this model.

4.4 Relationship Between Disease-Specific HRQoL and Audiologic Variables

Hypothesis 2(b) stated that the perception of disease-specific HRQoL for adults with HI is related to the following audiologic variables, specifically (a) hearing aid ownership, (b) hearing assistance technology ownership, (c) better-ear pure-tone average, (d) worse-ear pure-tone average, and (e) the ability to understand speech in noise. All variables had a significant relationship to HHI scores in this study, thus these hypotheses were supported by the findings in this study. Specifically, HA ownership was associated with significantly greater handicap on both the Emotional and Social/Situational subscales of the HHI. HAT ownership was associated with significantly greater handicap on the Social/Situational subscale only. Both HHI subscales were also significantly positively correlated with SNR loss, BEPTA, and WEPTA; as hearing impairment increased, so did hearing handicap.

4.4.1 Device ownership

Participants in this study who reported owning HAs and HATs also reported significantly greater handicap associated with their HI on both subscales of the HHI. The relationship between the Social/Situational scale and HA ownership suggested strong clinical significance ($d=1.21$), and approached clinical significance for HAT ownership ($d=0.674$). The relationship between the Emotional subscale and HA and HAT ownership, while statistically significant, did not reach clinical significance.

These findings indicate that those participants who owned HA and HATs experienced greater handicap associated with both subscales, than those who did not own hearing aids. Recall that the HHI instructs participants to answer the HHI questions as if they were not using any assistive technology. These findings are consistent with Fischer and colleagues (2011) who conducted a population-based, prospective study for the purpose of identifying determinants of HA acquisition in older adults with HI. That study also found that increased perception of handicap as measured on the HHIE was correlated with HA acquisition. In that study and in this one, demographic characteristics were taken into account alongside objective audiometric data and perception of hearing handicap. One major difference between the two studies was that Fisher and colleagues were working within the United States service delivery model, which does not have a government-funded HA program as exists in NZ. It is possible that the greater perception of handicap caused by HI may have made the need for assistive technology use more pressing.

4.4.2 BEPTA, WEPTA, SNR loss

Audiometric variables were positively correlated with scores on both subscales of the HHI; as the degree of HI increased, the report of hearing handicap also increased for this sample. The relationship between degree of HI (BEPTA and WEPTA) and HRQoL as measured by the HHI is supported by some literature (Cruickshanks et al., 1998; Dalton et al., 2003; Newman et al., 1991; Ventry & Weinstein, 1982), but this has not always been shown to be the case, and in fact there are data from many other countries that differ from what was found in this study. This is not particularly surprising when considering that degree of HI accounts for less than half of perceived handicap in the USA (Ventry & Weinstein, 1982). Research from overseas also suggests the experience and impact of HI is personal and cannot be predicted based on thresholds (Swan & Gatehouse, 1990). Furthermore, the WHO-ICF shows us that the measurement of a disability, in this case audiometric data, does not measure

activity limitation or participation restriction caused for different individuals. That said, the data from this study have clearly shown thresholds to be related to perception of handicap as measured by the HHI. Therefore, given that all three audiometric variables explored in the present study significantly affected scores on both subscales of the HHI, the relationship between these variables for adults with HI in NZ needs to be further explored.

The ability to understand speech in noise was reflected in HHI scores in this study, wherein people who struggled to understand speech in the presence of background noise report feeling more handicapped by their HI than those whose scores on the QuickSIN reflected better understanding. It is likely that this decreased ability to understand speech would have a large impact on a person's quality of life.

4.4.3 Device ownership

Four additional questions were generated for the purpose of using discriminant analyses to differentiate HA and HAT owners from non-owners. The rate of HA ownership, and perhaps more importantly, usage – remains very low amongst people with HI who may benefit from HA use. Many variables have been explored as possibly contributing to the decisions to consult for HI, to purchase HAs, and to use HAs; this remains of particular interest to clinicians who wish to better serve adults with HI through, for example, the inclusion of measures that tend to be positive predictors of successful HA use. The four questions, applied to each of the technologies, were (a) which audiometric variables discriminate owners and non-owners? (b) Which demographic variables discriminate owners and non-owners? (c) Which quality of life variables discriminate owners and non-owners? (d) Based on the results of a-c, which of the significant variables discriminate owners and non-owners?

4.4.3.1 Discriminating audiometric variables between HA owners and non-owners

This study found that all audiometric variables (BEPTA, WEPTA, and SNR loss) discriminated HA owners from non-owners, thus supporting existing literature that shows significant positive relationships between a degree of HI and HA adoption (Fischer et al., 2011; Garstecki & Erler, 1999), and SNR loss and HA adoption (Robertson et al., 2012; Walden & Walden, 2004). Recall HA adoption is not solely related to degree of HI. Other influential variables to consider are social support, perception of hearing handicap, dexterity, activity limitation, and participation restriction (Cox et al., 2005; Fischer et al., 2011; Garstecki & Erler, 1998; Gopinath et al., 2011; Helvik et al., 2008; Humes et al., 2003). That these other variables have been shown to have positive relationships to HA adoption does not preclude the existence of a significant relationship between degree of HI and HA adoption in the absence of these other variables, as is shown in this study. The increased accessibility for HA ownership created by the governmental funding scheme in NZ, could contribute to the reduction of barriers to HA ownership, allowing those with greater difficulty hearing to trial HAs.

SNR loss also differentiated HA owners from non-owners in this study. This supports the results of the study by Robertson et al. (2012), which was a retrospective chart review that sought to determine the relationship between audiometric variables and first time HA adoption. In that study and in this one, a SNR loss had a positive relationship with HA acquisition and use. The sample size in that study ($N=144$) was similar to the sample size in this study. The authors encourage clinicians to consider the inclusion of audiometric data such as the QuickSIN when considering the recommendation of HA purchase to adults with HI. The data from this study support that recommendation.

4.4.3.2 Discriminating demographic variables between HA owners and non-owners

No demographic variables differentiated HA owners from non-owners. Specifically, the following demographic variables did not distinguish the two groups: age, relationship length, hours worked per week, income, ancestry, sex, education, city size, and sexual orientation. As previously mentioned, the relationship between demographic variables and HA ownership is complex, and this complexity is reflected in the mixed data reported in various overseas studies. Demographic factors such as older age, female sex, higher satisfaction with income, a family history of hearing impairment, and higher education level have been shown to have a positive relationship with adoption of hearing aids (Fischer et al., 2011; Garstecki & Erler, 1999; Kochkin, 1993, 2007, 2009), though not all data are supportive of these relationships (Gussekloo et al., 2003; Helvik et al., 2008). As previously discussed, sample demographics may have an impact on whether or not a significant relationship is reported; in this study, participants tended to report higher levels of these demographic factors. That is, there were more women than men, of higher age than younger age, reporting a higher income and level of education than the general NZ population; therefore the lack of trend present in this study may not be repeatable were a sample more reflective of the NZ population surveyed. Information regarding satisfaction with income, and family history of hearing impairment were not collected in this study.

4.4.3.3 HRQoL variables discriminating HA owners and non-owners

Scores on the HHI differentiated HA owners from non-owners in this study. The single most discriminating HRQoL variable was the Social/Situational scale of the HHI, followed by the Emotional scale of the HHI. These findings support data from overseas that have also shown a positive relationship between HHI scores and HA adoption, particularly studies by Gopinath and colleagues (2011), and Fischer and colleagues (2011). These studies also found that variables such as age, PTA, level of education, and self-perception of hearing

were significant predictors of HA ownership and use. This study also found PTA to discriminate the two groups, but the significant variables found in other studies (level of education, age) were not repeated. This may be due to the sample of this study reporting higher level of education and older age than the general NZ population, however more research is needed to see if education and age become significant variables in a sample more reflective of the NZ public.

4.4.3.4 Significant variables discriminating HA owners and non-owners

Discriminant analysis was used to determine the best five of all predictors included in this study for HA ownership. In this study, the most important predictive factor was perception of disease-specific HRQoL, specifically perception of Social/Situational handicap. Audiologic variables (WEPTA, SNR loss, and BEPTA respectively) were the next most important predictive factors for HA ownership, followed by the Emotional subscale of the HHI. These results suggest that in addition to severity of HI and the ability to understand speech in noise, HRQoL is an important indicator of decisions regarding ownership of HAs for this sample. Interestingly, no demographic variables were able to predict group membership amongst this sample.

4.4.3.5 Significant variables discriminating HAT owners and non-owners

Audiometric, HRQoL, and demographic variables discriminated between HAT owners and non-owners. All audiometric variables (BEPTA, WEPTA, and SNR) discriminated HAT owners from non-owners, where worse HI predicted HAT ownership. This is similar to the results of the discriminant analysis for HA ownership, suggesting similarities in decision making in terms of BEPTA, WEPTA, and SNR loss for both HA and HAT groups.

HRQoL variables also discriminated HAT owners from non-owners. The most predictive HRQoL measure was the HHI, in which both the Social/Situational and Emotional subscales of the HHI discriminated HAT owners from non-owners. Furthermore, the PCS scores were found to be significantly higher amongst HAT owners than non-owners, indicating better physical functioning amongst HAT owners than non-owners. Therefore, all HRQoL subscales could predict HAT ownership amongst this sample, except for the HHI emotional. There is a lack of data regarding influencing HRQoL factors for HAT adoption, but the results of this study show that, unlike with HA adoption, generic health-related measures of QoL are valuable predictors of HAT ownership for this sample.

Age and income also differentiated HAT owners and non-owners, while the remaining demographic variables (relationship length, hours worked per week, ancestry, sex, education, city size, and sexual orientation) were not significant. Once again, these results are quite different to those differentiating HA owners from non-owners, where no demographic variables were significant predictors of ownership.

While data exploring predictive variables for HAT ownership are lacking, the findings in this study show, overall, that distinguishing variables for both HAT and HA owners are very similar for this sample in that the groups were different based on all audiometric factors and disease-specific HRQoL. Additionally, age and income and PCS scores differentiate HAT owners from non-owners. This suggests that the factors influencing decision making for HAs and HATs are different, however further investigation in this area is needed. Furthermore, it must be noted that since there are many different types of HATs, further research may warrant looking at the relationships between ownership of each type of HAT and HRQoL.

4.5 Clinical Implications

This study aimed to examine perception of HRQoL for adults with HI living within the NZ context, and to compare those results to data from overseas. This examination of HRQoL has led to some interesting outcomes that have implications on the clinical practice of audiology. While there is need for further research about how HI impacts HRQoL for adults in NZ, the results of this study suggest clinical value in engaging disease-specific HRQoL instruments (such as the HHI) as well as audiometric tests for the ability to understand speech in noise (such as the QuickSIN), in the clinical setting. Use of such tools might assist the clinician to serve clientele in ways that are meaningful and beneficial, and make more informed choices, leading to better outcomes.

For example, the results of this study show that a disease-specific quality of life measure is not only sensitive to the degree of HI for this sample, but is also the single most significant discriminating factor for HA adoption. That is, disease-specific quality of life worsens as hearing worsens. Recognising the presence and importance of these variables, via use of quality of life surveys in the clinic can help the clinician make more patient-focused clinical decisions.

Interestingly, income was not an important variable in HA uptake. Clinically this serves as a useful reminder that the choice of rehabilitation strategies for adults with HI living in NZ ought not to be considered or rejected based upon their level of income. Even though approximately half of people report expense as a barrier to purchasing HAs in the USA (Kochkin, 2007), this study has shown that no significant difference in income was present between the HA ownership groups. Furthermore, the findings in this study suggest that clinicians would be amiss to make any sort of assumptions about the decisions a person may make about purchasing hearing aids, based on their income. Further research amongst a

sample with an average reported income closer to that reported in the NZ census (Statistics New Zealand - Tatauranga Aotearoa, 2013) would provide more information in this area.

For this sample, people who owned HAs did not tend to own HATs, and vice-versa. Those who owned HAs and those who owned HATs also had different significant discriminant variables. For example, as discussed above, people in this study who had purchased HAs had done so regardless of income level. However, income was a significant variable amongst the HAT owners. This might suggest that the decision-making criteria for HAs and HATs are different. Clinically, it is important to remember that these findings do not suggest those with higher incomes did not use HATs, and that some people indeed used both.

With regards to the decision to purchase HAs, SNR loss was found to be an important variable. The more difficulty people had understanding speech in the presence of background noise, the more likely they were to have purchased HAs. While the results of this study may not extend to the ability of the QuickSIN to predict the successful ongoing usage of hearing aids in the elderly (Walden & Walden, 2004), a test of speech understanding in noise can provide the clinician with information not revealed via other audiometric tests. For example, although pure-tone audiometry does provide information about the softest sound a person can detect the majority of the time when presented in a silent setting, this setting is not particularly representative of everyday life. A speech in noise test, while not an entirely realistic replication of communication situations, does provide important information about an individual's experience with their HI, which can assist with counselling. Furthermore, the results of such tests may provide the clinician with information about whether or not to suggest hearing aids to any given individual. Future research into the relationship between

SNR loss, HA purchase, and satisfaction and use of HAs would provide useful clinical information.

4.6 Limitations and Directions for Future Research

This study has several limitations. Due to the study's design, the results found herein are only descriptive and correlational and therefore do not provide information on causal relationships between the variables. For example, the results of this study suggest there is a relationship between higher income and less social handicap and higher MCS and PCS scores; it remains unknown whether it is the higher income that influences these HRQoL scores, or if it is that adults with HI who have better social functioning, and less negative mental and physical effects, are able to earn more income. These relationships are complex and while the results of this study cannot disentangle these relationships, future research may aim to provide a more sophisticated analysis of these relationships for the NZ population.

This study only focused on the perception quality of life and hearing handicap from the perspective of the person with the HI. Since the impacts of HI extend beyond the individual and can have profound impacts on those around them as well as their relationships with these people, exploring the impact of HI from the perspective of communication partners would provide valuable additions to this data. Including the perspective of family members or significant others could be accomplished using the spousal version of the HHI (HHIE-SP; Newman & Weinstein, 1988).

Another limitation of this study is the inability of the results to indicate exactly how the participants feel about the impact of HI on their lives. Just as severity of hearing impairment does not necessarily determine the extent to which one's communication and lifestyle are impacted by HI, it is beyond the scope of HRQoL instruments to expand upon

the meaning of the results for the individual participants. That is, two individuals could have the same score on one of the HRQoL questionnaires used in this study, yet feel quite differently about the impact of HI upon their life. Further research into the impact of HI on perception of HRQoL might include open-ended questions conducted in interview or written format.

A demographic variable that has previously been shown to be significantly and positively correlated with HA ownership is that of family history of HI (Fischer et al., 2011). Since this study did not collect information regarding family history of hearing loss from the participants, the relationship of this particular variable to HA ownership in the NZ context remains unexplored.

With regards to the decision to purchase HAs, SNR loss was found to be an important variable, while income was not. The more difficulty people had understanding speech in the presence of background noise, the more likely they were to have purchased HAs. While the results of this study may not extend to the ability of the QuickSIN to predict the successful ongoing usage of hearing aids in the elderly (Walden & Walden, 2004), the results of this study suggest that a test of speech understanding in noise can provide the clinician with information unable to be attained via other audiometric tests. Future research into the relationship between SNR loss, HA purchase, funding and income, and satisfaction and use of HAs would provide useful clinical information. Furthermore, useful clinical information could be gained by future research that addresses similar topics surrounding use of specific types of HATs.

4.7 Conclusion

The present cross-sectional study aimed to examine the perception of HRQoL for adults with HI living in NZ. Two widely-used HRQoL instruments were used to investigate the relationships between several demographic and audiologic variables, including ownership of HAs and HATs. The results of this study suggest that the negative impacts of HI on HRQoL as reported overseas are also present in NZ, and that both perception of HRQoL and ownership of HAs are correlated with severity of HI and the ability to understand speech in noise. Interestingly, HAT ownership and HRQoL scores were both significantly affected by income level, but HA ownership was not. Demographic variables aside from income and age tended not to significantly impact HRQoL or ownership of HAs or HATs. These results indicate that further QoL research is warranted amongst the HI population in NZ to identify and understand any causal relationships present amongst these variables.

The clinical value of identifying the relationship between various demographic and audiometric variables and HRQoL is to contribute to the base of evidence employed by the clinician working within the NZ context. A desire to enhance awareness of the client may inspire the clinician to identify and understand the HRQoL trends present in this population. Including the HHI in a clinical evaluation can give the clinician additional meaningful information about the impact of HI for the person they are serving. Furthermore, the results of this study also suggest a clinician would gain valuable information by employing such tools as a speech understanding in noise test alongside their pure-tone and speech audiometry.

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Appendix A – Information Sheet

University of Canterbury
Department of Communication Disorders
Private Bag 4800
Christchurch 8140
New Zealand



STUDY INFORMATION

You are invited to participate as a participant in the research project entitled
“Perception of quality of life in adults with hearing impairment in New Zealand.”

The aim of this project is to better understand how adults with hearing impairment who live in New Zealand feel about their quality of life. Previous research has shown that many things can impact on a person’s feelings about quality of life, including amount of hearing impairment, age, gender, sexual orientation, relationship status, hearing aid use, level of education, and employment status. But, there has been no research that has looked specifically at how those things may impact on how adults in New Zealand feel about their quality of life. Information from this research project may help improve clinical practice and engagement in New Zealand.

Your involvement in this project will include: (1) filling an information sheet about yourself, (2) filling in standardised questionnaires about your perception of quality of life: both as it relates to your hearing impairment and your overall health, and (3) participate in a hearing test at a participating audiology clinic. The hearing test will be provided to you at no cost. In addition, a petrol voucher will be provided to you to help cover the costs of travelling to the clinic.

You have the right to withdraw from the project at any time, including withdrawal of any information you have provided. Your involvement (or withdrawal) in this project will not affect your ability to seek and receive services at the hearing aid clinic where your hearing is tested.

You will be asked about your experience living with hearing impairment and the risk of participating in this study includes the possibility of feelings of distress as you complete the standardised questionnaires.

The results of the project may be published, but you may be assured of the complete confidentiality of data gathered in this investigation: the identity of participants will not be made public without their consent. To ensure anonymity and confidentiality, your name will not be used on your hearing test, information sheet, or questionnaires. Instead you will be given a participant number. In addition, the consent form will be kept in a locked cabinet in a locked room in the Department of Communication Disorders on the University of Canterbury campus in Christchurch, New Zealand. Electronic data (without your identifying information) will be kept on password-protected computers that are stored in a locked room in the

Department of Communication Disorders on the University of Canterbury campus in Christchurch, New Zealand.

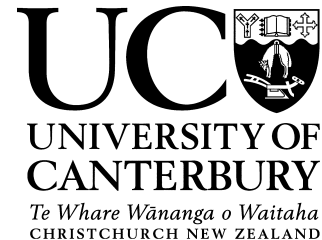
This project is being carried out by Dr Rebecca Kelly-Campbell and is funded by the College of Science Early Career Research Grants at the University of Canterbury. In addition, Kamea Lessoway, who is a Master of Audiology student at the University of Canterbury, will serve as a research assistant and may also have access to the data. Dr Kelly-Campbell will be pleased to discuss any concerns or questions you may have about participation in the project and may be reached on 64 (3) 364-8327.

The project and been reviewed ***and approved*** by the University of Canterbury Human Ethics Committee.

Appendix B – Participant Information Form

PLEASE RETURN THIS FORM

University of Canterbury
Department of Communication Disorders
Private Bag 4800
Christchurch 8140
New Zealand



ID _____

Date _____

PARTICIPANT INFORMATION

In order to get a better understanding about how adults with hearing impairment in New Zealand perceive quality of life, we need to ask you some questions about yourself.

Please answer every question honestly and to the best of your ability. Be assured that the answers you provide will be kept in confidence.

1. What is your current age? _____

2. At what age did you notice you had a hearing problem? _____

3. How would you describe the onset of your hearing problem (how quickly or slowly)?

4. How would you describe the severity of your hearing problem?

6. What is your current gender? _____

- If applicable, what was your former gender? _____

7. How would you describe your sexual orientation? _____

8. What is your current relationship status? _____

9. How long has this been your current relationship status? _____

10. How would you describe your ethnicity/cultural identity? _____

11. What is your most difficult communication situation? _____

12. Have you ever worn hearing aids? _____

a. If so, at what age did you start wearing them? _____

b. How often do you wear them (if at all)? _____

c. How would you rate your level of satisfaction with them? _____

13. Have you ever used hearing assistance technology (e.g., amplified phone)?

- If so, what have you used? _____

14. What is the highest level of education you completed? _____

15. At what age did you complete your highest qualification? _____

16. What is your annual net income (after any taxes or deductions)? _____

17. Do you have any dependents (children or adults) living at home? _____

- If so, how many? _____

18. Do you work outside the home? _____

- If so, how many hours a week do you work? _____

19. How would you describe the nature of your work (e.g., retail, office, labour)?

20. How would you describe the community where you reside (e.g., large city, rural, town)?
